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THE SUPPLY EFFECTIVENESS OF
COOPERATIVE LOGISTICS

Kimble D. Pendley, GS-13
Griffin L. Ratley, Captain, USAF

LSSR 28-79A

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The purpose of this research was to compare the levels of supply support afforded to different types of Foreign Military Sales (FMS) customers. To do so, we compared requisition response times for investment (depot reparable) items and critical investment assets. We tested for a significant difference in requisition service days between demands against Cooperative Logistics Supply Support Arrangements (CLSSA) and Blanket Order cases. The technique used was Analysis of Variance (ANOVA). The primary variables were requisition service days and requisition type (programmed or non-programmed) issue priority and procurement lead time were secondary variables. Two years of requisition data from all FMS countries were sampled. The data supported the null hypothesis--that there is no statistically discernible difference between CLSSA (programmed) requisitions and Blanket Order Case (non-programmed) demands.

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THE SUPPLY EFFECTIVENESS OF COOPERATIVE LOGISTICS

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degrees of Master of Science in Logistics Management

By

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and

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has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

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Ronald J. Dierk Maj, USAF

COMMITTEE CHAIRMAN

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CHAPTER 1

INTRODUCTION

In this chapter, we will first set the stage for our research with a brief background highlighting the problem area of follow-on supply support for Foreign Military Sales customers. Next, we will focus several problem variables, limit the research area, and state our objectives.

Background

The end of World War II signaled the beginning of a new era for the United States in world affairs. Emerging from WWII as the world's richest, most powerful, and most technologically advanced nation, the US assumed a leadership role in a global environment marked by the polarization of the world community into two camps. The struggle between these two camps has challenged the ability and willingness of the US to use its riches, power, and technology effectively in the world arena. One of the major implements the US has developed since the last World War to further its foreign policy objectives (24:Part I, pp. B-1, C-1) is security assistance.* As long as part of our national

---

*See Appendix A - Glossary of Terms. We invite the reader to refer to the Glossary for more detail on several terms throughout this research which are peculiar to the foreign military sales/logistics arena.

strategy is to rely on the personnel and material resources of friendly foreign governments for augmented support in any conflict, the importance of security assistance must be underscored.

The majority of security assistance in the first decade following WWII was channeled through the Military Assistance Program* as Grant Aid--nonreimbursable "gifts" of surplus items to foreign nations (10). In the last twenty years, however, the preponderance of security assistance has been via sales with formal agreements binding the Department of Defense (DOD) to rather specific responsibilities (24:Part III, p. C-2). We now have active Foreign Military Sales (FMS) cases with over 60 countries in support of more than 8,000 aircraft (6). In the two decades the Foreign Military Sales program has existed, arms in excess of $124 billion have been sold to 92 nations (12:1).

The sale of arms means more than the transfer of the hardware and settling of financial accounts. In order for our allies to use this equipment effectively, the full range of follow-on logistics support must be made available as well. FMS customers, like our own bases, need both initial supply support and follow-on replenishment. Initial FMS support of one year's spares lay-in is provided with the weapon system package sale (20:p.4-23). On the other hand, replenishment spares may be purchased in a variety of ways. Eligible friendly foreign governments may purchase spares support with varying levels of investment and expected

supply response. The effectiveness of follow-on supply support is just as vital to foreign forces as it is to our own.

Over a decade ago, Mr. Hugh Gownley, then the Deputy for Management to Deputy Assistance Secretary of Defense (International Logistics Negotiations), emphasized the importance of follow-on support.

> It would be difficult to overestimate the importance of US logistics support in the Foreign Military Sales Program. While the US can cite the competitive price, ready availability and high quality of its weapon systems, it is the support capability that the US can offer that is most often the 'key' element in a foreign country's decision to buy American systems. Foreign logisticians realize that 'follow-on' costs . . . can equal or exceed the initial cost of a system in a relatively few years. Such an investment must not be speculative, and the best guarantor is the US Department of Defense [7:72].

This commitment to provide quality follow-on support takes on another dimension in light of the recent growth of FMS. in 1968, FMS totaled $1.18 billion (12:2). In fiscal year (FY) 1978, US arms sales totaled $13.8 billion, and DOD anticipates FY 1979 sales to reach $14.4 billion (25:1). Not only has the volume of US arms sales increased, but the degree of complexity and level of sophistication of the weapons sold has increased markedly. The continuing growth in the sale of highly sophisticated weaponry to our allies, in conjunction with the DOD commitment to provide follow-on logistics support throughout the life cycle of the weapon system (7:71), places a long-term, complex responsibility on the US logistics system. That responsibility includes such diverse activities as maintenance, procurement, training,

engineering, transportation, supply, etc. on a worldwide scale. This research deals with the effectiveness of only one aspect of FMS logistics which, nevertheless, covers the full range of the above activities: follow-on supply support.

Problem Statement

We can find no definitive research which adequately investigates the supply effectiveness of FMS follow-on supply support. The problem for research, therefore, is to evaluate the routine follow-on supply support provided to Cooperative Logistics customers and to Blanket Order customers by comparing the requisition service times for programmed and non-programmed demands.

Limiting the Problem

In order to limit the problem for research, we will here discuss the various methods of purchasing follow-on supply support, define programmed and non-programmed requisitions, and describe the several categories of supply items in the DOD inventory. The reader will then better understand the scope of this study.

Methods of Purchasing Follow-On Supply Support

There are three methods for providing follow-on supply support to FMS customers: Firm Order Spares Cases ("B" designator), Annual or Blanket Order Spare Parts Cases

("R" designator), and Cooperative Logistics Supply Support Arrangements ("K" case designator)(1:2). Firm Order Spares cases are essentially a cash-and-carry operation for unique, nonrecurring situations. The customer specifies the range and depth of items or describes the service desired. A one-time sales contract is negotiated without collecting Price and Availability data. Pricing is estimated by adding a factor of fifteen percent to the material value of the case to cover possible price increases (20:p.4-25). In materiel cases, the customer is usually lead-time away from delivery of the order (1:2). Firm Order Cases are the instruments for ordering engineering and technical services as well as spares. Purchasing spare parts via Firm Order Cases is the least recommended method since the administrative time and expense involved in handling these cases is greater than that for "K" or "R" cases (20:p.4-25).

Next, Annual or Blanket Order Cases are established annually for dollar amounts only; i.e., items and quantities are not specifically delineated in the contract. Therefore, requisitions against these cases cannot be programmed or anticipated by the USAF supply system (20:p.4-37). Requisitions are processed using US Military Standard Requisitioning and Issue Procedures (MILSTRIP); however, AFR 400-3 is clear that unless the requested item is in excess position, the customer should expect to be lead-time away from delivery of the order and to pay the higher price associated with special, small lot procurement. USAF stock will not be used

to fill "R" case requisitions if support of our forces may be jeopardized (20:p.4-38). In neither "B" nor "R" cases can the US Air Force logistics system forecast requirements or initiate procurement action in anticipation of requisitions for specific items (1:3).

Thus, Blanket Order Spares Cases provide a more expeditious and economical means of obtaining frequently used spare parts than use of Firm Order Spares cases. However, Cooperative Logistics is the <u>most</u> highly recommended method of follow-on spares support. According to the May 1978 revision of AFR 400-3:

> Spare parts are usually provided more expeditiously under the Cooperative Logistics Supply Support Arrangement due to the minimization of leadtime. The purchaser is therefore encouraged to use the CLSSA [20:p.4-37].

Indeed, all four military departments have favored the establishment of CLSSA with buying nations, as opposed to alternate mathods of spares support, for over a decade (9:24). Current Air Force policy requires that a commitment to obtain follow-on supply support via a CLSSA be included in the Conditions section of every Systems Sale LOA (Letter of Offer and Acceptance) package. CLSSA cost estimates are also a required segment of the System Sale LOA (20:p.4-23).

Cooperative Logistics Supply Support Arrangements procedures and policies were specifically developed to best meet the supply demands of FMS customers. Within the limits of the agreement, the logistics systems of the FMS customer

and the US logistics system are merged (3:7). Purchasers of CLSSA must forecast their anticipated stock usage by line item, with the assistance of Air Force logisticians, just as USAF units forecast their requirements (20:p.4-38). To cover the cost of what they requisition, CLSSA buyers deposit down payments, or portions of the dollar value of their annual forecasted requirement, with DOD each quarter in advance (22:p.19-11).

CLSSAs permit the Air Force Logistics Command (AFLC) to increase stock levels in anticipation of the needs of participating customers via their forecasted (or programmed) requirements one year in advance (1:3). The CLSSA customer becomes a part of the US supply system on an equal basis with equal priority to similar USAF units (1:4; 20:p.4-38). Integration into the American defense logistics system provides the foreign military our experience, the use of an established worldwide supply system, reduction in costs by virtue of larger volume purchases, as well as knowledge and advice from logistics experts when necessary. The member countries also benefit by being able to establish demands on a worldwide data base (12:3-6).

Categories of Supply Items

The range of items which may be requisitioned as replenishment spares is subdivided into three groups. Service codes designate the type of item requisitioned and the source of material procurement funding (3:2). The categories

and associated service codes are:

Type Item	Service Code
Investment (AFLC)	A
Consumable (AFLC)	B
Consumable (DLA)	C

Parentheses indicate the DOD-designated item manager.

Investment items (Service Code A) are depot level reparables* which, by their nature, "constitute a greater investment by the purchaser and the USAF" (20:p.4-30) than consumable items. They are managed more stringently than either type of consumable. Requirements are forecast using several complex variables (e.g., failure rates, condemnation factors for both base and depot, etc.)(21:p.7-63).

On the other hand, consumables (Service Codes B and C) are relatively low cost items whose stock levels are established solely on the basis of recurring demands over the most recent eight quarters. They are managed only on a financial basis, and stock levels for customer nations are adjusted automatically by AFLC requirements computations systems (3:4).

Of the three categories of items described above--Service Codes A, B, and C--we chose to investigate customer service levels for only Service Code A items. These AF-managed investment/recoverable items were the focus of this research for several reasons. First, recoverable items are generally significantly more expensive than consumable items (Service Codes B and C). Also, procurement lead times

necessary for investment items are several months to years longer (4) than the time required to purchase most consumables.

These two factors--high cost and long lead time--have greatly influenced the degree of management control afforded investment items. In comparison with the management of EOQ/consumable items, the investment items are indeed scarcer resources and should have more stringent controls. Various professionals from the HQ AFLC/International Logistics Center suggested that Service Code A items should exhibit the most highly differentiated levels of customer service for programmed and non-programmed requisitions, especially because of this relative scarcity and tighter resource management (6; 17; 18).

A subset of both investment and consumable items is another category of materiel called critical items (see Figure 1-1). These are a group of items characterized by acute scarcity in the DOD supply system, caused by numerous possible factors, and manifested through high levels of NMCS* hours, cannibalizations, and War Reserve Material (WRM) withdrawals (4). Obviously, the AFLC system and item managers, and to a lesser extent, Defense Logistics Agency (DLA) item managers track critical assets very closely since these have a very great impact on aircraft availability and readiness of perhaps an entire fleet. For example, the TF-41 turbine blade became so critical in 1974, the entire fleet of A-7's were grounded worldwide (4).

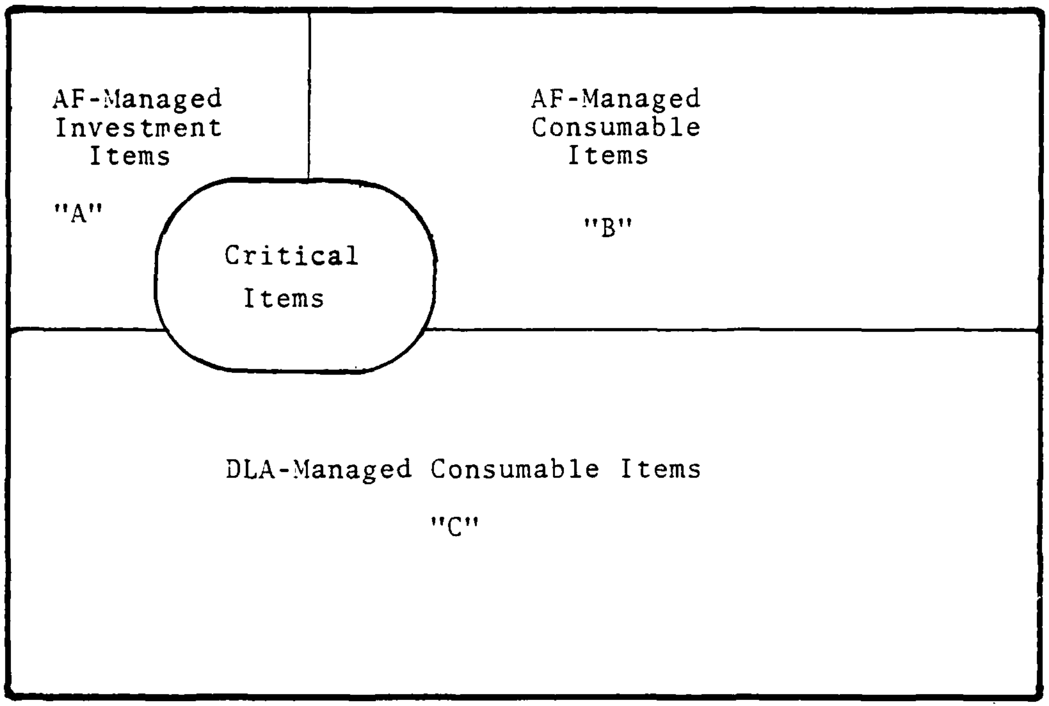


Fig 1-1. Categories of Supply Items

The AFLC Critical Item Program is designed to afford special management attention to the items (across all five Air Logistics Centers) whose inventory is critically low and negatively impacting aircraft availability. In order for an item to be designated "critical," it must first accumulate more than 1000 NMCS (Not Mission Capable-Supply) hours in a calendar month. Cannibalizations and WRM (War Reserve Material withdrawals also are tracked and evaluated as follows:

1 Cannibalization = 1 WRM withdrawal = 1 NMCS hour

Thus, several indicators of replenishment problems are included in the formula to identify potential candidates for the critical item list (4).

The D165B data system--the "Aerospace Vehicles and Selected Items of Equipment Mission Capability Requisition Status Reporting System"--automatically lists all items which breach the 1000 NMCS hour threshold. This D165B listing is then distributed to every inventory manager concerned. The inventory manager and various other levels of management review each potential candidate on the D165B listing. Consideration is made of the supply position of each item, the ready availability of suitable substitutes, the number of contract due-ins, the severity of item engineering or other supply problems. After several echelons of item review, only a fraction of those items on the D165B NMCS listing are actually entered in the command-wide critical item program (4).

Of the three major categories of supply items and their subset discussed here, there is a clear hierarchy of management/asset control exercised by AFLC. In rank order, from most stringent asset control to least control, the hierarchy is as follows:

1. Critical Items ("A", "B", or "C")
2. Investment Items ("A")
3. AF-managed Consumable Items ("B")
4. DLA-managed Consumable Items ("C")

This research will investigate requisition service times for investment and critical investment items only.

Differentiated Customer Service Levels

All foreign customer requisitions for supply items in the DOD inventory are submitted in MILSTRIP format like demands from any USAF base. The level of service afforded each request for materiel is determined by Issue Priority (IP) and whether the demand is programmed or not (23:5). The priority of every requisition is assigned by the purchasing country in accordance with their urgency of need, FAD (Force Activity Designator, assigned by the JCS), and UMMIPS (Uniform Materiel Movement and Issue Priority System) procedures. Priorities for FMS customers correlate with those for USAF base supply units: NMCS, and 01 through 15 (23:7).

Programmed requisitions refer to demands only against Cooperative Logistics Supply Support Arrangements, specifically only those recurring demands which were forecast at

least a year in advance. Conversely, all other requisitions are non-programmed. In the security assistance arena, the following demands are non-programmed (2:2):

1. all non-CLSSA requisitions
2. CLSSA requisitions which
   a. were not forecast a year in advance, or
   b. exceed the forecasted quantity.

Since some subsets of the universe described above are not germane to this research, we will not examine them (e.g., Grant Aid requisitions). The specific subset of interest will be delineated in Chapter 3, Research Methodology.

The programmed/non-programmed status of a requisition from a foreign customer determines how that demand will be processed through the USAF supply system. Programmed demands should be treated exactly the same as demands from American operational units. This is the purported strong advantage of acquisition through CLSSA. As shown in Figure 1-2, programmed requisitions which are NMCS or priority 01-08 will reduce available stock to zero. Priority 09-15 requisitions are filled only if assets are above the support level (2:4). This policy should net a considerable pipeline advantage for Cooperative Logistics customers.

The support and control levels are determined by the AFLC D041 "Recoverable Consumption Item Requirements Computation System." The control level is the worldwide gross annual requirement (Air Force and Cooperative Logistics), minus base repairs and base stock level. The support level

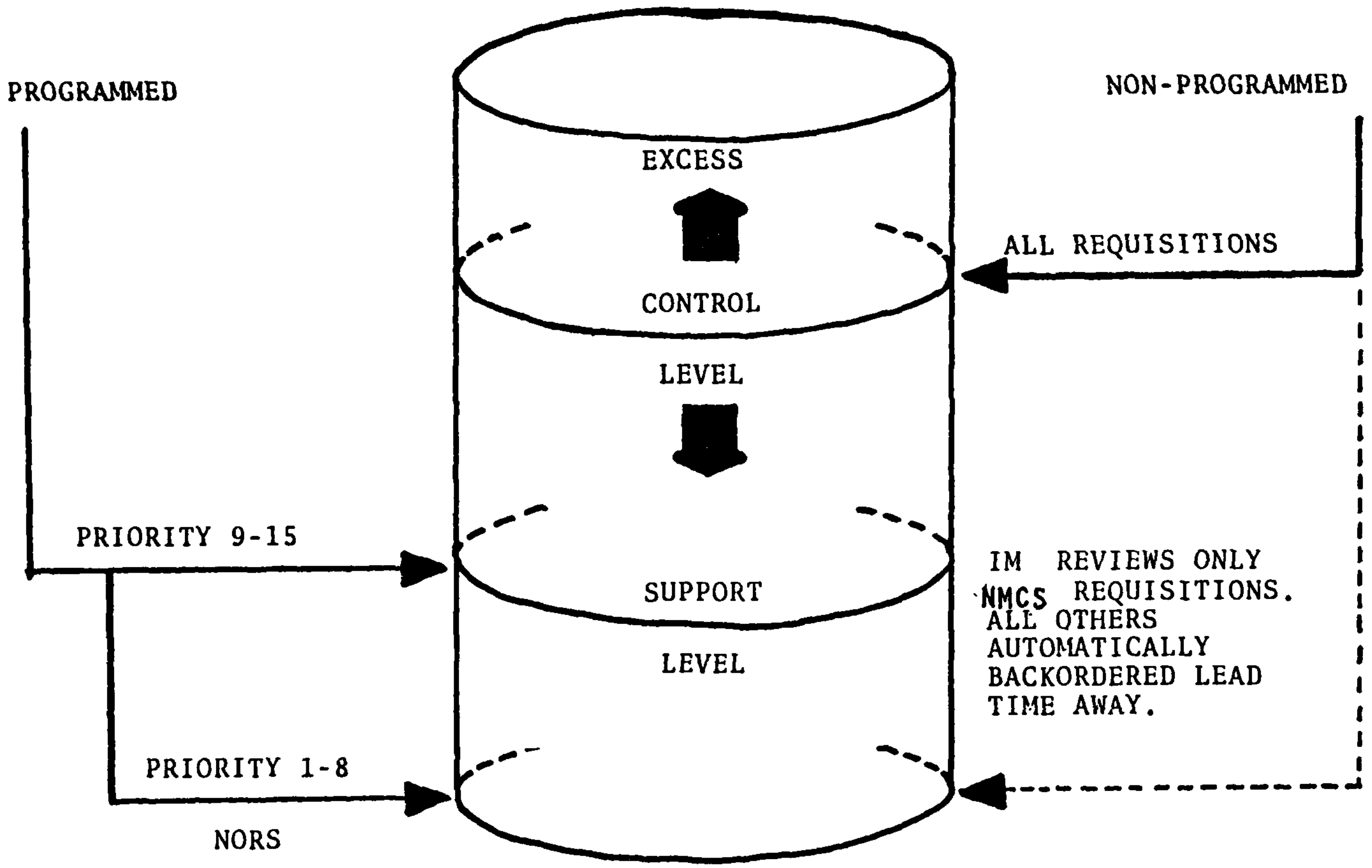


Fig 1-2. Resource Allocation to Programmed/Non-Programmed Demands

is 30 days requirement, or one month of stock (21:p.7-66). Using our last 30 days' worth of inventory to satisfy Cooperative Logistics demands is evidence of the preferential treatment intended for these customers.

Requisitions which are non-programmed, on the other hand, are never to be filled from current USAF inventories unless

1. the requested item is in excess supply, or
2. the requisition is NMCS priority, and the inventory manager judges that satisfying the demand from stock will not adversely affect support posture for USAF operational units (21:p.7-64).

Thus, the policy of filling FMS requisitions for replenishment spares clearly designs differentiated levels of supply support. Programmed CLSSA demands should enjoy a much faster response time than non-programmed demands of any kind. That is one of the main objectives of CLSSAs. We shall investigate whether this is the actual performance of the logistics system by evaluating demand response for the two most tightly controlled subsets of all assets in the Air Force.

Research Objectives

The objectives of this research are nearly identical, merely directed at investment items and the subset of critical investment items:

1. To determine if a significant difference exists

between the requisition service times for programmed and non-programmed requisitions for AF investment items.

2. To determine if a significant difference exists between the requisition service times for programmed and non-programmed requisitions for critical investment items.

Research Questions

In order to achieve the above objectives, we sought answers for the following research questions:

1. Is there a discernible difference in requisition service days for programmed and non-programmed demands from foreign governments for Air Force-managed investment items?

2. Does item criticality effect differentiated levels of service given to programmed and non-programmed requisitions?

Summary

Clearly, the favorite method of providing routine replenishment spares to foreign customers able to invest equity in the DOD logistics system is Cooperative Logistics Supply Support Arrangements. There have been doubts from some nations, however, that the USAF supply system does, in fact, afford enhanced support to customers who forecast usage instead of merely drawing against a Blanket Order Case.

To test whether some types of requisitioning receive better supply response than others, we have focused our research on programmed and non-programmed FMS demands.

Current policy on how these requisitions should be filled was explained. The several categories of supply items were also partitioned, and we justified narrowing our research to investigate only investment items and their subset of critical spares.

Only last year, an AFIT research effort drew unexpected attention to the issue of requisition response time. No significant difference in supply response time was found between Blanket Order case demands and CLSSA requisitions. This finding prompted management within the International Logistics Center and elsewhere in the security assistance community to request further research on this critical measure of any logistics system: requisition service time. The following chapter reviews research and other literature which is directly related to our research problem.

CHAPTER 2

RELATED RESEARCH

Introduction

Cooperative Logistics Supply Support Arrangements were established over fifteen years ago (7:71), yet surprisingly little has been written concerning the performance of this unique supply technique. A thorough search of the last twelve years of the Defense Documentation Center (DDC) and the Defense Logistics Studies Information Exchange (DLSIE) yielded no critical research outside of AFIT in this area. The purpose of this chapter is to review both completed and ongoing research that relates to the evaluation of CLSSAs. We will highlight four completed efforts and preview two that are ongoing.

Completed Research

White-Logan Thesis

An early evaluation of the Cooperative Logistics Support Program was completed by an AFIT thesis team in 1968. Published only four years after the Department of Defense created CLSSA, this research effort provided a good critique of many facets of the program. Wing Commander Sydney White (RAAF) and Major Frank Logan III (USAF) examined Cooperative

Logistics spares support in an ambitious and impressive thesis covering a very wide range of topics. Their research hypotheses dealt with the following (26:11-12):

--the uniformity (or lack thereof) of CLSSA administration across the three US military services

--the adequacy of safeguards to prevent harmful stock drawdowns by CLSSA customers which could adversely affect spares availability for US operational forces

--the advertised cost minimization provided through CLSSA participation

--the effectiveness of CLSSA to allied countries as measured by supply response time, quality control, and standardization.

Although only the last hypothesis is directly related to our research, we shall review all their conclusions here for a good, general perspective of Cooperative Logistics.

White and Logan reported that each service had a different attitude concerning in-country stock levels, and that considerable controversy existed over the function and purpose of CLSSA. Whereas the intent of DOD was to provide spares from the wholesale depot level of the US logistics system to replenish wholesale foreign customer country stock levels, many allies apparently regarded CLSSA as a good wholesale to retail operation (26:27). Regardless of DOD intent as the seller, the opinion held by many buying nations, that CLSSA is an effective means to support base

level requirements directly, provided a clue to why CLSSAs may not perform as smoothly as designed.

There was considerable difference in the requirements, administration, and performance in Cooperative Logistics Supply Support Arrangements across the U.S. Army, Navy, and Air Force. All these variations considered, White and Logan concluded that, under CLSSA, the greatest savings in investment costs was realized by a reduction in the forward ordering pipeline rather than a reduction of in-country stock levels (26:30).

Regarding the adequacy of safeguards to protect stock for operational US forces, White and Logan concluded that American combat readiness and the effectiveness of the logistics system to meet US requirements was not impaired by the Cooperative Logistics program (26:45). However, their analysis in this area was theoretical rather than statistical, and may be weak. Their conclusions were based on policies for satisfying requisitions instead of actual performance data (26:41-45).

In their evaluation of the economic factors surrounding Cooperative Logistics, White and Logan gave an unqualified recommendation to the program. They considered the economic advantage noteworthy, as compared to procuring direct from US commercial industry sources. As a total spares package arrangement, CLSSA enabled friendly foreign governments to support their weapons systems most cheaply by providing the greatest value for the money invested (26:66).

The White-Logan research objective most directly related to this thesis concerned the effectiveness of supply support under CLSSAs. The essential factors of support effectiveness, according to these authors, were requisition response time, quality control, and standardization. All three determinants of supply effectiveness were superior to private industry performance (26:80).

Supply response time was computed in the same manner as we have in this research--from julian date of the requisition document number to julian date of shipment. Although the priority of the demands were not considered in their analysis, White and Logan determined that the average time consumed in processing all requisitions from CLSSA customers in 1968 was 33 to 42 days (26:74). They judged this performance to be within acceptable limits; however, they did not compare programmed vs. non-programmed demand response, nor did they break out any particular category of items.

Kaine-Wilhite Thesis

Another thesis, completed in 1969 by an AFIT team, presented a buyer's view of foreign military sales. Ten years ago, according to Kaine and Wilhite, the buyer could procure logistics support only two ways : through "normal military sales procedures" or by entering into a Cooperative Logistics Supply Support Arrangement (9:24). Even then, all military services apparently preferred establishment of a CLSSA.

However, Kaine and Wilhite explained that a customer may wish to limit his CLSSA commitment for several reasons. First, a country may need to limit its initial investment in the U.S. military inventory for fiscal reasons. Also, a buying nation may prefer to restrict the range and quantity of items purchased from American sources in order to use or develop its own domestic industry to the maximum extent possible in supporting their defense systems (9:25). This implication that CLSSA customers negotiate a support program which is only a fraction of their anticipated requirements provided another clue to loss of effectiveness of CLSSA.

Although Kaine and Wilhite did not critically evaluate CLSSA performance, they did enlighten us on several points wherein buyer perspective is quite different from our perspective as the seller. Whether or not customers buy follow-on support via CLSSA, they expect to have a voice in determining the conditions of the system sale. Certainly those who invest equity in USAF inventories expect preferential treatment (9:26) over other nations who have no equity in the supply system. Given that the priorities of our customers may at times conflict with US best interests, the current USAF policy requiring CLSSAs with new weapon sales will probably continue to be challenged until we can prove that Cooperative Logistics does, in fact, provide the advantages we advertise. After all, foreign buyers are single-minded in purpose--they wish to obtain as much for their money as they can (9:19).

JLC Report

More recently, the DOD Joint Logistics Commanders sponsored an ad hoc group three years ago to investigate the impact of FMS on major weapon system acquisition programs and management processes. The group selected seventeen DOD Project Managers for major systems and collected information from them on the effect which FMS requirements had on their projects. The FMS impact on eight specific areas was evaluated: cost, schedule, production base, manpower, logistics, training, procurement, and project management (8:4).

Although the bulk of the study was concerned with acquisition programs and, therefore, the initial provisioning of spares support, there was a section devoted to follow-on logistics problems. Reflecting the official DOD policy, the study report states (8:31):

> Follow-on spares/repair parts and recoverable/reparable items are provided most effectively through Cooperative Logistics Supply Support Arrangements (CLSSA).

The study concluded that support capability for US forces may be degraded by foreign customers requisitioning excessive quantities of materiel. Although both public law and USAF policy prohibit procurement of items in anticipation of a foreign sale which is not covered by a Cooperative Logistics Arrangement, waivers of the standard lead time limitation may be granted (8:32). These waivers and the ensuing release of Service stocks, possibly below the reorder point or control level, may also negatively affect the

quality of logistics support given to USAF units. They could also negate the advantage of quick supply response times provided by the CLSSA program over Blanket Order and Firm Order cases.

Significantly, the study report had two recommendations which apply to system acquisition as well as replenishment problems. First, all participants in FMS programs need to emphasize to foreign customers the importance of timely planning and adequate requirements forecasts. Secondly, OSD must minimize diversion of assets to foreign countries (8:12). Overriding existing supply policies not only potentially jeopardizes support for our own forces, but also degrades the CLSSA customer's right (through purchased equity in the DOD supply system) to equal support.

Myers-O'Grady Project

Captains Myers and O'Grady conducted preliminary research comparing two supply support concepts in 1978. The two support concepts studied were Cooperative Logistics Supply Support Arrangements (K cases) and Blanket Order Requisition cases (R). Although they found a significant difference in requisition service time by country, data would not support a hypothesis of significantly shorter processing time for K cases in general (13:4). This cast doubt on one of the claims of CLSSA--that programming requirements provides a customer with the same level of support as an operational USAF unit with a comparable Force Activity Designator (FAD),

which by implication and design should be of a higher order than support of non-programmed demands (24:Part III, p.F-2).

The purpose of the Myers-O'Grady statistical study was ". . . to compare the processing time for similar material requisitioned on 'K' and 'R' type cases [13:1]." Only programmed requisitions for K cases were included in the study. Nine countries were randomly selected (of a possible population of 17 countries supporting the C-130 and 7 supporting the F-4) for the analysis (13:1). Only these two aircraft were chosen because several countries flew them, and they both were still active in the USAF. The F-4 and C-130 programs provided both the stability of older aircraft programs and a large, potential data base of customers and demands. A random sample of Cooperative Logistics customers was selected, and another random sample of countries not participating in CLSSA was taken (13:3). Requisitions compared were assumed to be for "similar material" for C-130 and F-4 support. How the material similarity criterion was met was not recorded nor defined.

Requisitions for all Service Code C items, i.e., those consumable economic order quantity (EOQ) spare parts managed and supplied by the Defense Logistics Agency (DLA), were deleted (13:2). The possible consequence of or reason for these deletions was not reported. All non-programmed CLSSA requisitions were also deleted. This may have weakened their results by not analyzing the largest segment of the population of non-programmed replenishment demands.

Of the 7,363 requisitions covered in the Myers-O'Grady analysis, over 88 percent were AF-managed consumables (15:21). This high ratio of EOQ items may also have biased the findings of their study. Although policy for filling FMS requisitions is the same for all types of items, the relatively higher stock levels and safety stock for EOQ consumables should afford a higher fill rate from inventories than off-the-shelf fill for investment items. Discussions with managers in the AFLC/International Logistics Center support this theory. They generally expect the greatest discernible difference in requisition service days between programmed and non-programmed demands for investment (Service Code A) items (6; 17; 18).

Ongoing Research

The statistical project completed last year by Captains Myers and O'Grady stirred a great interest in CLSSA supply performance. The presentation of their findings to the AFLC/International Logistics Center surprised many FMS managers. Since they drove a wedge into the purported advantages of CLSSA, many other research efforts have been directed at the merits of Cooperative Logistics. Two other AFIT thesis teams are currently investigating CLSSA supply support. Their research will be completed in September 1979.

First, Captains James Winn and John Breed are conducting research on pricing procedures under Cooperative Logistics Supply Support Arrangements. They plan to

examine the advertised claim that CLSSA effects lower prices overall than other methods of obtaining replenishment spares (27:6). By comparing the final billing prices for programmed and non-programmed requisitions, they plan to determine if a significant price differential exists for CLSSA customers. Besides contrasting actual prices paid by FMS customers, Winn and Breed also will compare current pricing procedures for programmed and non-programmed orders to investigate whether current guidance has been implemented effectively (27:7). Their conclusions and recommendations for management relative to CLSSA pricing advantages will complement our research.

The other AFIT thesis team is researching the comparative support given to programmed and non-programmed FMS requisitions. Colonel Mahmood Moradmand, Major Charles Johnson, and Mr. James Callahan are analyzing the supply effectiveness of Cooperative Logistics Supply Support Arrangements. They also intend to test the hypothesis that programmed requisitions receive faster processing than non-programmed demands (5:5). By using a data base of all demands satisfied during the current fiscal year (FY79), they will compare average service time for requisitions in the two categories. Another of their objectives is to "determine how and why the AFLC logistics system is failing to provide a better level of support for programmed requisitions" if no significant difference can be found in the treatment of the two kinds of demands (5:12).

Summary

The major advantages of Cooperative Logistics, according to many DOD publications (2:1; 24:Part III, p.F-1; 22:p.19-9), are the short requisition response time realized from pooling requirements with the larger USAF system and the consequent discounts available to participants in a large procurement effort. The AFLC supply system is not authorized to forecast or procure in advance of requisition receipt for a specific non-programmed requirement; therefore, the non-CLSSA customer and Cooperative Logistics buyers with non-programmed demands should be lead-time away from receipt, except in those cases where the item is in excess stock position. In other words, programmed requisitions are filled from stock; non-programmed requisitions should be back-ordered and a buy should be initiated for the amount of the demand (see Figure 1-2).

All the official DOD and USAF literature reviewed claims longer lead times for supply of comparable items to be a fact of life for customers without programmed, recurring demands. However, no evidence was found to validate this claim. White and Logan computed an average requisition service time for all categories of items, but did no comparative research. Kaine and Wilhite provided clues to why CLSSA may not perform as designed, but performed no critical research either. The JLC Report emphasized good FMS planning and warned against overriding supply policy lest the ability

to support American forces become jeopardized. Finally, the Myers-O'Grady research did not support the claim that programmed requirements were filled more rapidly than non-programmed requirements.

The aim of this study is to provide the critical research necessary to definitively evaluate the effectiveness of CLSSA by comparing programmed and non-programmed requisition response times. The methods and procedures used to provide such an evaluation are the subject of the next chapter.

CHAPTER 3

RESEARCH METHODOLOGY

After discussing the previous and current research on CLSSA in the last chapter, we will now describe the foundation on which our own research was built: the research design, the variables, population description, sampling and data collection procedures, assumptions and, finally, the analysis technique.

Research Design

In order to address the approach to answering the research questions, they are restated for ease of reference:

1. Is there a discernible difference in requisition service days for programmed and non-programmed demands from foreign governments for Air Force-managed investment items?

2. Does item criticality effect differentiated levels of service given to programmed and non-programmed requisitions?

Answering these two questions required analysis of transaction data on hundreds of requisitions and statistical testing of that data. Since our management problem concerns the presence or absence of a differential in requisition servicing times across two types of requisitions (programmed and non-programmed), we tested the following hypotheses

for two samples of data (general and critical investment items):

$$H_0 : \mu_p = \mu_n$$

$$H_1 : \mu_p \neq \mu_n$$

where

μ_p = population average service time for programmed demands

μ_n = population average service time for non-programmed demands

Specifically, the objective of the research was to determine what relationship existed between requisition service days and the type of requisition, i.e., programmed or non-programmed, for the general population of investment items and for the subset of investment items designated as critical. Proper assessment of this hypothesis necessarily required consideration be given to other variables that could affect requisition service time. The researchers felt that the major variables that should be included in the analysis, in addition to requisition type, were issue priority and procurement lead time.

The Variables

In the research design, a number of variables to be used in the analysis were proposed: the dependent variable, requisition service days; the independent variables, requisition type, issue priority, and procurement lead time. Here,

the variables are defined and described.

Requisition Service Days

This dependent variable is the performance measure used to test for differences in supply system response. It is specifically defined as the difference between the order date of the requisition and the shipping date (the day the item clears the ALC warehouse). The order date is the date of receipt by the H051 "International Logistics Program Central Accounting and Reporting System." Using these dates nullified both the effects of the delay of requisitions sent via mail or ambassadorial channels, and any difference in delivery times for different modes of transportation or geographical locations.

Split shipments required special treatment. That is, fill time for a multiple item requisition which was filled via several deliveries was computed as a weighted average. For each partial shipment, the fill time was multiplied by the ratio of the number of items shipped to the number ordered. For example, a requisition placed for 10 items on day 7080, with shipments of four each on 7088 and six each on 7180, has a fill time of:

$$\begin{aligned}(4/10) \cdot 8 \text{ days} + (6/10) \cdot 100 \text{ days} &= 3.2 + 60 \\ &= 63.2 \text{ days} \\ &\approx 63 \text{ days}\end{aligned}$$

Requisition Type

This independent variable was the primary concern of this research. All requisitions can be categorized by

the two possible values of this variable: (1) programmed and (0) non-programmed.

Programmed requisitions are forecast one year in advance and are recurring demands against Cooperative Logistics Supply Support Arrangements. Non-programmed requisitions include all non-Cooperative Logistics demands, CLSSA demands for quantities in excess of the established stock level, and CLSSA demands for items without programmed requirements for one year.

Issue Priority

In order to simplify the research design and reduce computer core space required to execute the analysis program, it was advantageous to combine the various levels of issue priorities into three groups. Because NMCS orders generate special interest and handling procedures, it was felt that all NMCS orders should be combined into one group. The chart below indicates how the other priorities were classified.

Requisition Issue Priority	Category
NMCS	1
1-8	2
9-15	3

Procurement Lead Time

Because we theorized that the procurement lead time (PLT) affects the supply effectiveness measure of requisition service days, we also collected the PLT data for all items in both general investment and critical item samples. Card

interrogation of the D041 (Recoverable Consumption Item Requirements Computation System) data bank yielded PLT data for the most recent contract for almost every NSN requested. A few items were not current in D041; therefore, we called the item managers and obtained the latest procurement lead time for these items.

The PLT data were grouped into three categories to make it more meaningful.

Procurement Lead Time	Category
less than 13 months	1
13 to 18 months	2
greater than 18 months	3

Population/Sample Description

The population under consideration for analysis consisted of all FMS requisitions for replenishment spares, as recorded in the AFLC data system H051, the International Logistics Program Central Accounting and Reporting System. The focus of the research is on the routine supply of replenishment spares via sales. For that reason, the population to be sampled was reduced to all programmed requisitions and those non-programmed requisitions from K and R cases only.

After limiting our sample population to only requisitions for Service Code A items, we needed to ensure valid comparisons could be made once a sample of each type of requisition was extracted. Myers and O'Grady compared requisitions for "similar material" (12:4), without explanation

of how they knew or guaranteed this similarity. The researchers assumed valid comparisons could be made only if programmed and non-programmed demands were for the same items; therefore, the populations to be sampled were further limited to National Stock Numbers (NSN) known or believed to have both kinds of requisition activity.

Sampling Procedures

Two hypotheses were proposed in the research design, one relating to the general population of investment items, the other relating to critical investment items. This made it necessary to draw two separate samples. Throughout the rest of the research the reader will encounter references to these samples. In order to easily distinguish the two, the researchers will consistently refer to the samples as critical and noncritical. The names are not meant to be qualitative in nature, but are merely to distinguish requisitions for those investment items that have been designated as critical from the requisitions for the general population of Service Code A items (the former is a subset of the latter). For a complete list of the NSNs selected for both samples, the reader is referred to Appendix C.

Noncritical Item Sample

In order to collect a sample from the general population of FMS requisitions for investment items, we needed first to isolate NSNs with both programmed and non-programmed demands.

To do this, we used the H051.ZMAO "SSA Demand Analysis List." This is a special, one-time report compiled in 1978 for the HQ AFLC/International Logistics Center (ILC) by extracting all SSA requisitions for Service Code A items which were processed in H051 between 1 May 1977 and 9 May 1978. Requisition data were extracted from the .LTAO and .LTBO, H051 historical record files. Both stock level quantities, and programmed and total demands were listed by NSN by country (19).

We manually flagged every item which met the following criteria:

(a) Programmed Demand Quantity > Zero

(b) Programmed Demand Quantity ≠ Total Demand Quantity

(The difference between the programmed and total demands in (b) is evidence of both programmed and non-programmed requisition activity.) In this manner, a sampling group of 1990 candidate NSNs were identified. From this list, we drew a simple random sample of 60 items with both programmed and non-programmed requisition activity over the period covered. We used the CREATE random number generator to select the sample.

Critical Item Sample

We used the "Critical Item Summary Report" referred to in Chapter 1 to isolate items for our sample of critical investment items. This report is compiled every month. Both recoverable and consumption-type items are on the list,

which averages about 300 items each month. The "Critical Item Summary Report" is prepared and distributed by HQ AFLC/LOLSC, Wright-Patterson AFB. Its Report Control Symbol (RCS) designation is LOG-LO(M)7601. An example of the Critical Item Summary Report is provided in Appendix B.

In order to collect and analyze data on programmed and non-programmed FMS requisitions for critical items, it became necessary to first sample from the critical item listing and next request a stock number interrogation from H051. The objective of investigating critical items at all was to analyze requisition system behavior for resources that are known to be scarce. If there were little or no difference between requisition fill times for programmed vs. non-programmed demands in general, we would certainly expect a significant difference in fill times for critical items. By the same reasoning, if there were a difference in the general population, we would expect an even larger difference for critical items.

The authors collected a sample from the Critical Item Summary Report listings from the second, third and fourth quarters of FY78. By beginning our search for sample NSNs midway through the fiscal year, we collected requisition data on both items which had been critical for many months, and items which were not critical at the beginning of our data collection period but later became critical. This approach should maximize the variety of item support situations on which we collected data.

Therefore, the Critical Item Summary Reports as of 31 March, 30 April, 31 May, 30 June, 31 July and 31 August 1978 were used to collect a sample of critical NSNs. First, we purged all consumable items (ERRC Codes XB3 and XF3) from the listings, since we were researching only depot reparable (or investment) items. Next, of the investment items left on the listings (Service Code A ≡ ERRC Code XD2), we purged all NSNs applicable to weapon systems which have not been sold to foreign nations (e.g., B-52, C-135, etc.).

The remaining candidates for critical item sampling we manually verified against the H051.GGGO listing as of 78178 (27 June 1978). This special request H051 product lists all Service Code A items with current Cooperative Logistics programmed requirements. After this final step, we had a sampling population of 109 critical, Service Code A items with a known FMS programmed requirements forecast on a CLSSA. Finally, using the CREATE random number generator, we sampled 29 critical NSNs for which to collect requisition satisfaction data. Of these 29, only 15 met our criteria for having both programmed and non-programmed requisitions for the period covered.

Data Collection Procedures

Once the two samples of NSNs were identified, the task was to gather and sort the data to be analyzed. In this section, the procedures used in collecting the appropriate requisitions for each sample and in categorizing

data values are described.

Requisition Collection

All USAF FMS requisitions flow through the AFLC H051 system for recording and accounting before being forwarded to various Air Logistics Centers (ALCs) or Defense Supply Centers for fill. This central accounting system is the most reliable source for data measuring requisition processing times. In order to span a reasonable period of time and to compensate for the cyclic nature of procurement, data on requisitions was collected for two fiscal years, October 1976 to September 1978.

Once the noncritical and critical investment items on which to collect requisition data were selected, we submitted a punched card for each chosen NSN to the ILC/XR. The stock number interrogation was performed using the H051.LTAO and .LTBO historical files. The active history file (.LTAO) contains detailed status transactions on all requisitions which were delivered in the last 120 days. The .LTBO is the inactive history file, containing detailed status of all FMS requisitions delivered over 120 days ago. Both files are sequenced by country, case, and age of requisition. The .LTAO and .LTBO together constitute over one hundred (100) reels of tape (19).

Several hundred pages of printout listings of the H051.R061 were produced as a result of interrogating the historical files. The .R061 is the "Status of Selected

Stock Part Numbered Items Report." Thus, the output received was a complete transaction history of all FMS requisitions ever submitted for each NSN requested. The report lists the following information by NSN: ALC responsible for item management, unit of issue, quantity ordered, requisition document number, case designator, country code, issue priority code, NMCS status, programmed or non programmed demand status, ERRC code, price, order date, ship date, H051 close out date, and much more.

Because the .R061 lists all historical demand activity, several NSNs had over ten years of requisitions against five or six different types of FMS cases in the output. Therefore, the researchers manually processed the .R061 report and flagged only those requisitions which were against K or R cases, and shipped during fiscal years 1977 and 1978.

Creation of Data Files

After determining the Issue Priority category, the Procurement Lead Time category, the requisition service days, and program status for each requisition, the researchers input the following elements of data into two free field CREATE data bases: NSN, Issue Priority (1-3), Programmed-Non-programmed status (0 or 1), Requisition Service Days, and Procurement Lead Time (1-3).

List of Assumptions

The populations under consideration, the sampling and data collection procedures were based on the following list of

assumptions:

1. Each NSN chosen to compare the two categories of requisition activity may be treated the same as any other NSN.

2. A valid comparison of service levels must be against the same items--only items with both programmed and non-programmed demands were eligible for random sampling.

3. Two years of requisition data will provide reliable results.

Analysis Procedures

The research design called for testing the hypothesis that average requisition service days for programmed and non-programmed requisitions are equal. We theorized that other variables, issue priority and procurement lead time, were likely to affect requisition service time and could cause difficulty in making an unbiased and accurate test of the hypothesis. In order to determine the relationship between requisition type and service time, it was necessary to separate and interpret the effects of all of the variables working together. The technique best suited for this type of effects test is analysis of variance (ANOVA). The adaptation of the ANOVA technique to computer processing made it ideal for this study.

Summary

In this chapter, we have outlined the steps taken to provide an evaluation of programmed and non-programmed

requisition service times. In particular, the research design was specified, the variables were identified and defined, the sampling population was described and limited, the sampling and data collection procedures explained, the assumptions listed, and the technique for the analysis was identified. Next, we will discuss the analysis.

CHAPTER 4

ANALYSIS AND EVALUATION

Introduction

At this point in the research, the scope has been narrowed, the problem defined, and the variables for analysis specified. The core of this chapter centers on determining if significant relationships exist between the variables in question. The existence of significant relationships will be determined by the use of Analysis of Variance (ANOVA). We will begin with a general discussion of the ANOVA model and its assumptions, then proceed with an assessment of the appropriateness of this technique for our research design. We then address ourselves to the actual analysis and results of our study.

The ANOVA Model

The analysis of variance is a versatile statistical technique for the study of relationships of one or several independent variables and a dependent variable. The basic concept is to specify a mathematical model which represents all sources of variability. The ANOVA model then partitions this variability into its component parts (11:43). This mathematical partitioning can become exceedingly complex and cumbersome. Fortunately, the technique lends itself to

adaptation to the computer. The speed, wide range of options, and statistics available through the software programs of the Statistical Package for the Social Sciences, Version 6 (16: 393-436), enhance the versatility and utility of the ANOVA method.

The problem for research concerns the determination of significant differences among several population means or, equivalently, testing a hypothesis that the population means measured in requisition service days are all equal for programmed and non-programmed orders. By establishing a significance for this null hypothesis, we are alternately either forced to accept the null hypothesis or reject it in favor of the alternate hypothesis which states that the means are different. Symbolically, the hypotheses are written in this manner:

Null hypothesis H_0: μ programmed = μ non-programmed

Alternate H_1: μ programmed $\neq$ μ non-programmed

The significance of the difference (if one exists) is established by the ANOVA model and, in our case, evaluated by the F test and its associated F distribution of critical points.

The F statistic is the ratio of the variance explained by a variable and the remaining or residual variance (14:447-448). For a given variable, sample size and desired confidence level, an F critical point can be determined. If the computed F ratio is smaller than the critical F point at a given confidence level, the null hypothesis cannot be rejected. Conversely, if the computed ratio is larger than the critical

F, the null hypothesis can be rejected (14:449). All of the tests in this study were conducted at the 95% confidence level. That is to say, 95 times out of 100 we would not reject the null hypothesis when the null hypothesis was true (15:408-423).

The ANOVA model has two subtypes: the random effects model and the fixed effects model. In the random effects model, the treatment levels, the different values that a variable can assume, are themselves only samples of the greater population of possible treatments. The researcher analyzes the effects of these sample treatments and makes inferences concerning the greater population of treatments (11:51). In the fixed effects models, the treatment levels represent the total possible population of treatments in which the researcher is interested (11:51). By grouping the various treatments in this study, we have achieved a fixed effects model for this research. Table 4-1 illustrates this technique on the following page. Note that all possible levels of the independent variables are included as possible values which makes the use of the fixed effects model possible.

The ANOVA model for one-way classification is as follows:

$$X_{ij} = \hat{\mu} + \hat{\alpha}_i + e_{ij}$$

where

X_{ij} = the jth sample observation of the ith treatment class

$\hat{\mu}$ = the estimated grand mean of all X_{ij} values over all treatments

TABLE 4-1

Variable List

	Variable Name*	Possible Values
Independent Variables		
Requisition Type	"PCODE"	(0) Non-programmed (1) Programmed
Issue Priority	"IP"	(1) NMCS (2) Priority 1-8 (3) Priority 9-15
Procurement Lead Time	"PLT"	(1) Less than 13 mos (2) 13 to 18 mos (3) More than 18 mos
Dependent Variable		
Requisition Service Days	"FILLTIME"	(0 - ∞) in days

*Variable name is the code used for computer processing and is found on all computer output in this study.

$\hat{\alpha}_i$ = the deterministic row_i effect, or the extent to which X_{ij} values reflect a consistent deviation from μ

e_{ij} = the stochastic error attributed to random variations within each row or group

The multiple effects model for testing more than two variables is essentially an extension of this design.

Assumptions of ANOVA. Use of the ANOVA model involves four major assumptions:

1. The population is normally distributed and the population mean μ is unknown.

2. The data points were randomly selected.

3. The row fluctuation, e_{ij}, is normally distributed with a mean of zero and a variance of σ^2 that is equal to the

population variance.

4. The variance of the population is homogeneous (14:426).

In any research where survey data (that is, "real world" as opposed to experimentally controlled data) are used, it is not reasonable to expect such data to precisely fit the assumptions mentioned above. Fortunately, the ANOVA model is reasonably robust with respect to some departures from these assumptions (14:501). The data collection procedures outlined in Chapter 3 permit the researchers to accept the position that each of the observations are indeed random and independent. The assumptions of normality and homogeneity of variance deserve some special attention.

The assumption of normality requires that the error terms for each level of a factor or variable follow a normal distribution. In order to test the data to be processed against this assumption, each of the levels of the variables were processed by computer under the "SIMFIT" program from the School of Systems and Logistics Computer Software Library. The program compares the data to various theoretical frequency distributions, produces a histogram, and lists statistical parameters concerning the data. The histograms for the factor levels are assembled in Appendix D.

The results of this analysis were that none of the factor levels was distributed normally. All of the factor levels were skewed to the right. That is, a concentration of data points existed at the lower end of the scale with a long

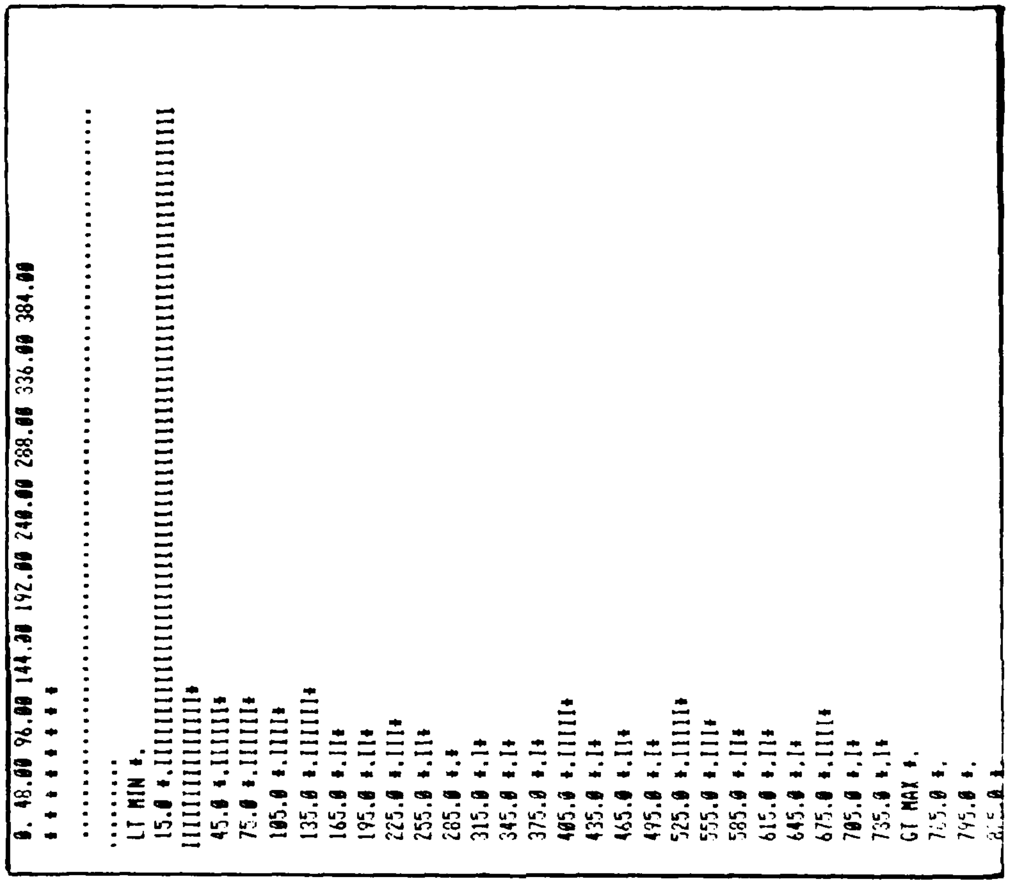


Fig 4-1. Sample Histogram

tail trailing to the right as in Figure 4-1 above.

Intuitively, one would expect there to be some differences in the variance in at least some of the factors in this study. For example, we find not only a shorter delivery time for short lead time items, but a smaller variance as well. This is reasonable since the longer lead time could drive up the time to deliver in those cases where a requisition was placed on backorder, which would cause the variance to increase.

The standard deviation is a measure of the variance. The degree to which the standard deviations differ for each variable can be seen by referring to Table 4-2. Note that there is considerable variation within some of the variables. It is important to understand that the ANOVA model does not require the variance to be equal between variables but only within the same variable. For example, it is not necessary for the variance of issue priority to equal that of procurement lead time and requisition type. The meaning of the homogeneity of variance assumption states that within a variable, the levels should be equal. Ideally, the three levels of the variable "issue priority" would have the same variance, the two levels of requisition type would have the same variance, etc. It is obvious from Table 4-2 that this is not the case.

Assessment. How do these departures from the assumptions of normality and homogeneity of variance affect the analysis? Kirk indicates that the ANOVA model and the associated F-distribution are sufficiently flexible when used with the fixed effects model to handle moderate departures from the normal distribution, provided the populations are homogeneous in form (11:63). The histograms in Appendix D will bear out the fact that the various levels of each factor are generally homogeneous in form.

The problem of unequal variance affects the F-test in terms of significance and sensitivity. These effects are only slight when the factor sample sizes are approximately equal

TABLE 4-2

Summary of Variable Level Means and Standard Deviations

Variable	Count	Mean	Standard Deviation	Standard Error
NONCRITICAL ITEMS				
Requisition Type				
Non-Programmed	427	209.7	237.0	11.4
Programmed	448	209.3	264.0	12.4
TOTAL	875	209.5	251.0	8.4
Procurement Lead Time				
(1) Short	162	86.6	123.0	9.6
(2) Medium	379	128.9	183.0	9.4
(3) Long	334	360.5	287.2	15.7
TOTAL	875	209.5	251.0	8.4
Issue Priority				
(1) NMCS	282	213.6	252.6	15.0
(2) 1-8	438	227.2	264.3	12.6
(3) 9-15	155	151.9	197.0	12.8
TOTAL	875	209.5	251.0	8.4
CRITICAL ITEMS				
Requisition Type				
Non-Programmed	105	251.5	244.7	23.8
Programmed	184	74.1	126.1	9.3
TOTAL	289	138.5	197.6	11.6
Procurement Lead Time*				
(1) Short	75	75.6	120.4	13.9
(2) Long	214	160.6	214.2	14.6
TOTAL	289	138.5	197.6	11.6
Issue Priority				
(1) NMCS	122	58.3	116.4	10.5
(2) 1-8	121	173.1	209.8	19.0
(3) 9-15	46	260.4	245.3	36.1
TOTAL	289	138.5	197.6	11.6

*Because of the small sample size, Procurement Lead Time was divided into only 2 categories: (1) 13 months and under and (2) greater than 13 months

(14:514). Large differences in sample size can have correspondingly large effects on the confidence coefficients of the statistic being compared. With these two violations of the assumptions in mind, the research was continued with the knowledge that conclusions and inferences made as a result of the analysis must be tempered with judgment because of the violations of these assumptions (14:514). The loss of some sensitivity and significance is not particularly harmful to the study since our interests were oriented toward finding gross differences rather than discovering fine shades of differences between the two populations.

Analysis Procedures

The general outline of the research plan was to break the study into two parts: 1) the requisitions against non-critical items and 2) those requisitions for critical items, as defined in Chapter 3.

The data for each group were processed using the Honeywell CREATE Computer and the SPSS program software. More specifically, a simple single-factor analysis was used to determine what, if any, differences existed in requisition service days between programmed and non-programmed requisitions. Other variables were then added in order to enhance the validity of the findings by confirming or denying the existence of special joint effects that may occur between variables. We will discuss the results of the analysis of noncritical items first and then turn our attention to the

results of the critical item data. For each comparison, a null and alternate hypothesis was proposed and a critical F point determined from F distribution tables. If the F ratio from the computer input was larger than the critical F, then we rejected the null hypothesis, and concluded the alternate hypothesis had some validity. For all comparisons, a 95% confidence level was specified, keeping in mind that the actual confidence level was something less than 95% because of the failure of the data to precisely meet the ANOVA assumptions.

Analysis of Noncritical Item Requisitions

One-Way ANOVA

The sample data included 875 requisitions almost evenly divided between the two basic groups: 427 programmed and 448 non-programmed. The single factor ANOVA compared the requisition service days ("FILLTIME") against the type of requisition ("PCODE"). The computer generated an F statistic which we compared to the critical F from the Table of Critical F Points (28:716-717).

In this case, with a confidence level of 95% and 1 degree of freedom in the numerator and 874 degrees of freedom in the denominator of the F ratio, the critical F was 3.814. The analysis of variance table is shown in Table 4-3. Note the F ratio was only .001, much less than the critical F. Therefore, the null hypothesis cannot be rejected. The mean requisition service days of the two groups were within

TABLE 4-3

ANOVA Table (Noncritical One-Way)

VARIABLE FILLTIME HØ51 DATE TO SHIPPING DATE

ANALYSIS OF VARIANCE

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN GROUPS	1	35.ØØØØ	35.ØØØØ	Ø.ØØ1	Ø.93Ø
WITHIN GROUPS	873	55Ø98523.ØØØØ	63114.ØØ1Ø		
TOTAL	874	55Ø98558.ØØØØ			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR	MINIMUM	MAXIMUM	95 PCT CONF INT FOR MEAN		
GRPØØ	427	2Ø9.7377	237.Ø26Ø	11.47Ø5	1.ØØØØ	823.ØØØØ	187.1919	TO	232.2835
GRPØ1	448	2Ø9.3393	264.Ø473	12.4751	1.ØØØØ	865.ØØØØ	184.8222	TO	233.8563
TOTAL	875	2Ø9.5337	251.Ø813	8.4881	1.ØØØØ	865.ØØØØ	192.8743	TO	226.1932
	FIXED EFFECTS MODEL		251.225Ø	8.493Ø			192.8647	TO	226.2Ø27
	RANDOM EFFECTS MODEL		Ø.2818	Ø.1993			2Ø7.ØØ18	TO	212.Ø656

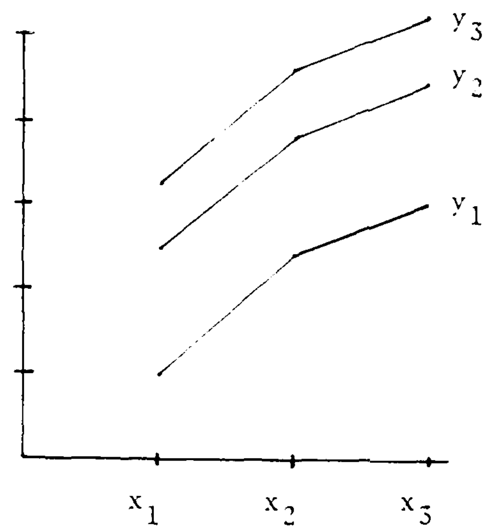
one half day of each other. In both cases, the standard deviation was very large, indicating a wide range of values in both groups.

In order to assure ourselves that other important variables were not affecting the comparison, a multiple factor or three-way ANOVA model was also used. The two variables added were issue priority (IP) and procurement lead time (PLT). The multifactor ANOVA model is an extension of the one way model that has the same assumptions. The three way ANOVA measures the combined effect of each factor level in the presence of the other factors. The sum of these effects are the main effects.

Multifactor ANOVA

When more than one independent variable is considered, there is a possibility of special joint effects mentioned earlier. These joint effects are called interactions (14: 557-560). Interactions are present if effects of one variable on another are unequal at different values. The interaction concept is more easily understood when presented graphically. Figure 4-2a represents the theoretical relationship of two variables with no interaction. Figure 4-2b depicts two variables with interaction. Both figures depict two 3-level variables.

Figure 4-2a indicates a similar relationship at all levels. Figure 4-2b shows little effect at level 1, but a large effect at level 2 and a medium effect at level 3. The



Note the relationship is constant for all x values.

Fig 4-2a. Two Variables with No Interaction

The interaction is evidenced by the changing relationship of x and y across different x values

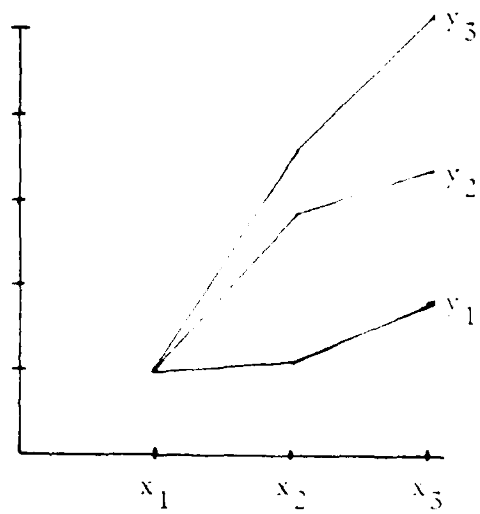


Fig 4-2b. Two Variables with Interaction

three factor interaction is more difficult to describe but the principle is the same (14:643). The F test is used to determine the significance of interactions. The null hypothesis is that all of the possible interactions are zero (effects are constant across all value levels). The alternate hypothesis states that at least one of the interactions is significant (14:611).

The technique used to analyze the multifactor ANOVA is as follows: 1) examine for three-way interactions; 2) determine the importance of three-way interactions; 3) examine two-way interactions; 4) determine their importance; and 5) examine main effects on factor level means (14:588-589).

The three-way ANOVA computer output is presented in Table 4-4. The critical F for three-way interaction was determined to be 2.37 (14:812), indicating the presence of a significant three-way interaction.

None of the two factor interactions involving program status were significant (refer to Table 4-4). Turning to the main effects, note that the variable PCODE (programmed or non-programmed) was not significant in the presence of the other variables. Stated in other words, the amount of variation in requisition service days (FILLTIME) that is explained by the type of requisition (PCODE) was not significant.

The Multiple Classification Analysis shown in Table 4-5 illustrates the effects of each level of each variable in the analysis. The grand mean, the average mean of all 875 requisitions, was 209 days. The unadjusted mean for each level of

TABLE 4-4

ANOVA Table (Noncritical Three-Way)

* * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *

FILLTIME H051 DATE TO SHIPPING DATE
BY IP   ISSUE PRIORITY NMCS=1 1-8=2 9-15=3
PCODE   0=NONPROGRAMMED 1=PROGRAMMED
PLT   PROCUREMENT LEAD TIME

* *

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS	2839375.125	5	567875.023	12.189	0.001
IP	93156.448	2	46578.224	1.000	0.999
PCODE	8154.261	1	8154.261	0.175	0.999
PLT	2618754.500	2	1309377.250	28.106	0.001
2-WAY INTERACTIONS	680727.539	8	85090.942	1.826	0.068
IP PCODE	107351.307	2	53675.653	1.152	0.317
IP PLT	310730.070	4	77682.518	1.667	0.154
PCODE PLT	69880.286	2	34940.143	0.750	0.999
3-WAY INTERACTIONS	515703.008	4	128925.752	2.767	0.026
IP PCODE PLT	515703.008	4	128925.752	2.767	0.026
EXPLAINED	15173266.500	17	892545.086	19.159	0.001
RESIDUAL	39925296.500	857	46587.277		
TOTAL	55098563.000	874	63041.834		

875 CASES WERE PROCESSED.
0 CASES (0. PCT) WERE MISSING.

NONCRITICAL NSNS THREE WAY ANOVA

TABLE 4-5

Multiple Classification Analysis Table

(Noncritical Items)

*** M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S ***

FILLTIME H051 DATE TO SHIPPING DATE
BY IP ISSUE PRIORITY NMCS=1 1-8=2 9-15=3
PCODE 0=NONPROGRAMMED 1=PROGRAMMED
PLT PROCUREMENT LEAD TIME

GRAND MEAN = 209.53

VARIABLE + CATEGORY	N	UNADJUSTED DEV'N	UNADJUSTED ETA	ADJUSTED FOR INDEPENDENTS DEV'N	ADJUSTED FOR INDEPENDENTS BETA	ADJUSTED FOR INDEPENDENTS + COVARIATES DEV'N	ADJUSTED FOR INDEPENDENTS + COVARIATES BETA
IP							
1	282	4.09		-31.68			
2	438	17.74		1.18			
3	155	-57.57		54.31			
			0.11		0.12		
PCODE							
0	427	0.20		-14.81			
1	448	-0.19		14.12			
			0.00		0.06		
PLT							
1	162	-122.84		-110.67			
2	379	-80.54		-127.57			
3	334	150.98		198.44			
			0.48		0.62		

variables is shown as a deviation from the grand mean. The adjusted score is the effect of a specific level of a variable, adjusted for the effects of the other variables in the analysis (16:416). For example, the unadjusted effect of issue priority 1 (NMCS) is +4.58 days, or approximately 214 days. This runs counter to what one would expect for NMCS requisitions.

Note that when issue priority 1 is adjusted for the influence of requisition type and procurement lead time, the adjusted mean is approximately 32 days below the grand mean, or 177 days. This could indicate that more NMCS orders are placed for long lead-time items. The adjusted effect on programmed and non-programmed requisitions indicates that there is a 28 day difference between the two in favor of non-programmed requisitions. However, this should not be construed as evidence that non-programmed requisitions receive better service. Because of the size of the two samples and the large variance of both, a difference of 28 days is not sufficient to statistically distinguish one group from the other. Statistically speaking, we can only say that there is no difference between the two; i.e., we cannot reject the null hypothesis.

Summary Analysis of Requisitions for Noncritical Items

The single factor ANOVA indicated that the type of requisition (programmed or non-programmed) made no statistically significant difference in requisition service time. Stated another way, the type of requisition explained almost

none of the variation found in requisition service time. When the factors thought to be important in explaining the difference in filltime were entered into the analysis, the effect of requisition type did not change. Programmed requisition service time was found to be indistinguishable from non-programmed service time.

Analysis of Critical Item Requisitions

The procedures used in processing the critical item data were essentially the same as for the noncritical items. A sample of 289 requisitions was taken from those National Stock Numbers defined in Chapter 3 as critical items. Slightly more than one-third, or 105, of the requisitions were non-programmed while the remaining 184 were programmed requisitions. The same problems were encountered in determining the appropriateness of the data for the ANOVA model in that the data did not exhibit a normal distribution, nor was the sample variance within the treatment levels always equal. The histograms of the factors are contained in Appendix D. Like the noncritical items, the distributions were homogeneous in form although nonnormal. Because of the large disparity in sample sizes within some cells, the effects of unequal variance on some comparisons need special attention.

One-Way ANOVA

The critical item data were run on the computer using the subprogram One-Way (16:422-425) to determine the effect of requisition type (programmed or non-programmed) on

requisition service days. The analysis of variance table is shown on Table 4-6. The results of this first test indicated a substantial difference exists between response time for programmed and non-programmed requisitions. The grand mean for both groups was 138 days. The mean for non-programmed requisitions was 251 days, while the programmed mean was 74 days. If we consider the worst case (referring to the 95% confidence interval for the means of the two groups) for programmed requisitions and the best case for the non-programmed requisitions, the difference is still over 112 days.

The critical F point for this test was 3.00 (14:812) while the computed F ratio was 66.079. This extreme difference between the computed and the critical value indicates that requisition type explains a substantial amount of the variation in requisition service days. We therefore reject the null hypothesis that the two means are equal (14:580), and accept the alternate hypothesis: programmed demands for critical items do receive significantly better service than non-programmed demands for critical items.

Multifactor ANOVA

In order to confirm the results of the one-way test, a multifactor ANOVA was run, bringing issue priority into the model and then procurement lead time. The ANOVA table from the two-way run is shown in Table 4-7. The two-way interaction between issue priority (IP) and requisition type (PCODE) was not significant. That was interpreted to mean that the effects of issue priority on requisition type were

TABLE 4-6

ANOVA Table (Critical One-Way)

VARIABLE FILLTIME H051 DATE TO SHIPPING DATE

ANALYSIS OF VARIANCE

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
BETWEEN GROUPS	1	2105249.5625	2105249.5625	66.079	0.000
WITHIN GROUPS	287	9143717.0000	31859.6411		
TOTAL	288	11248966.5000			

GROUP	COUNT	MEAN	STANDARD DEVIATION	STANDARD ERROR	MINIMUM	MAXIMUM	95 PCT CONF INT FOR MEAN
GRP00	105	251.5619	244.7775	23.8878	4.0000	814.0000	204.1914 TO 298.9324
GRP01	184	74.1033	126.1548	9.3003	1.0000	619.0000	55.7538 TO 92.4528
TOTAL	289	138.5779	197.6333	11.6255	1.0000	814.0000	115.6962 TO 161.4595
FIXED EFFECTS MODEL			178.4927	10.4996			117.9119 TO 159.2438
RANDOM EFFECTS MODEL			130.0860	91.9847			-1030.1981 TO 1307.3538

TABLE 4-7

ANOVA Table (Critical Two-Way)

* * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * *

FILLTIME H051 DATE TO SHIPPING DATE
BY IP   ISSUE PRIORITY NMCS=1 1-8=2 9-15=3
PCODE   0=NONPROGRAMMED 1=PROGRAMMED

* *

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS	2743314.906	3	914438.305	30.860	0.001
IP	376150.086	2	188075.043	6.347	0.002
PCODE	261565.354	1	261565.354	8.827	0.003
2-WAY INTERACTIONS	28540.309	2	14270.155	0.482	0.999
IP PCODE	28540.309	2	14270.155	0.482	0.999
EXPLAINED	2863158.125	5	572631.625	19.325	0.001
RESIDUAL	8385809.000	283	29631.834		
TOTAL	11248967.125	288	39058.914		

289 CASES WERE PROCESSED.
0 CASES (0. PCT) WERE MISSING.

CRITICAL ITEMS TWO WAY ISSUE PRIORITY AND PCODE

approximately the same for each level of priority. That is, the difference between non-programmed requisitions and programmed requisitions for issue priority 1 (NMCS) was the same at priority level 2 (priority 1-8) and priority level 3 (priority 9-15).

The main effects also proved significant for both variables. As one would expect, the means for the levels of issue priority were not equal. The presence of the variable requisition type (PCODE) did not interfere with that relationship. More importantly, the reverse is also true. In the presence of issue priority, requisition type (PCODE) continued to be a significant factor in explaining the variation in requisition service time. The Multiple Classification Table (Table 4-8) indicates that after adjusting for issue priority, the mean for programmed requisitions was 104 days less than the mean for non-programmed requisitions.

To strengthen our confidence in the results of the first two tests, a three-way ANOVA was run which included the requisition type (PCODE), issue priority (IP), and procurement lead time (PLT). Theoretically, if a disproportionately large number of programmed requisitions were for short lead time items, this could explain the better response time observed in the other tests.

Table 4-9 contains the three-way analysis of variance table. The critical F for three-way interactions was 3.00 (14:812), while the F ratio was only 1.805; therefore, we cannot reject the null hypothesis that the three-way

TABLE 4-8

Multiple Classification Table

(Critical Two-Way)

* * * M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S * * *

FILLTIME HØ51 DATE TO SHIPPING DATE

BY IP ISSUE PRIORITY NMCS=1 1-8=2 9-15=3

PCODE Ø=NONPROGRAMMED 1=PROGRAMMED

* *

GRAND MEAN = 138.58

VARIABLE + CATEGORY	N	UNADJUSTED DEV'N	UNADJUSTED ETA	ADJUSTED FOR INDEPENDENTS DEV'N	ADJUSTED FOR INDEPENDENTS BETA	ADJUSTED FOR INDEPENDENTS + COVARIATES DEV'N	ADJUSTED FOR INDEPENDENTS + COVARIATES BETA
IP							
1	122	-8Ø.18		-75.14			
2	121	34.53		42.91			
3	46	121.84		86.43			
			Ø.38		Ø.33		
PCODE							
Ø	1Ø5	112.98		73.Ø4			
1	184	-64.47		-41.68			
			Ø.43		Ø.29		
MULTIPLE R SQUARED					Ø.244		
MULTIPLE R					Ø.494		

CRITICAL ITEMS TWO WAY ISSUE PRIORITY AND PCODE

TABLE 4-9

ANOVA Table (Critical Three-Way)

* * * * * * * * * * * A N A L Y S I S   O F   V A R I A N C E * * * * * * * * * * *

FILLTIME H051 DATE TO SHIPPING DATE
BY IP   ISSUE PRIORITY NMCS=1 1-8=2 9-15=3
PCODE   0=NONPROGRAMMED 1=PROGRAMMED
PLT   PROCUREMENT LEAD TIME

* *

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS	189975.936	4	47493.984	1.723	0.144
IP	28543.489	2	14271.745	0.518	0.999
PCODE	69521.846	1	69521.846	2.522	0.109
PLT	169.177	1	169.177	0.006	0.999
2-WAY INTERACTIONS	474060.504	5	94812.101	3.439	0.005
IP PCODE	90390.126	2	45195.063	1.639	0.194
IP PLT	227136.871	2	113568.436	4.119	0.017
PCODE PLT	46.782	1	46.782	0.002	0.999
3-WAY INTERACTIONS	99551.711	2	49775.855	1.805	0.164
IP PCODE PLT	99551.711	2	49775.855	1.805	0.164
EXPLAINED	3611921.813	11	328356.527	11.910	0.001
RESIDUAL	7637045.313	277	27570.561		
TOTAL	11248967.125	288	39058.914		

289 CASES WERE PROCESSED.
0 CASES (0. PCT) WERE MISSING.

interactions were all equal. None of the two-way interactions involving requisition type were significant. The introduction of the third factor into the study had an interesting effect: it rendered all of the main effects insignificant. The most likely explanation for this effect is that the interaction between the three variables, coupled with a rather large variance and relatively small sample size, made the model ineffective in distinguishing the specific effects of the variables. It is noteworthy that of all the variables, requisition type (PCODE) explained more of the variation than either of the other variables.

The Multiple Classification Analysis shown in Table 4-10 indicates that the trend established in the first two tests is continued in the three-way model. Note that after adjusting for issue priority and procurement lead time, programmed requisitions enjoy a mean service time 112 days lower than the non-programmed requisition mean.

Summary Analysis of Critical Item Requisitions

The one-way analysis of variance showed requisition type to be a significant factor affecting requisition service time for critical investment items. In the two-way analysis, with requisition type and issue priority, the two variables were both significant factors in explaining the variation in requisition service time. The three-way analysis of variance tended to break down, and provided inconclusive results owing to the large variance of the factors and relatively small

TABLE 4-10

Multiple Classification Table

(Critical Three-Way)

* * * M U L T I P L E   C L A S S I F I C A T I O N   A N A L Y S I S * * *

FILLTIME H051 DATE TO SHIPPING DATE
BY IP ISSUE PRIORITY NMCS=1 1-8=2 9-15=3
PCODE 0=NONPROGRAMMED 1=PROGRAMMED
PLT PROCUREMENT LEAD TIME

* *

GRAND MEAN = 138.58

VARIABLE + CATEGORY	N	UNADJUSTED DEV'N	UNADJUSTED ETA	ADJUSTED FOR INDEPENDENTS DEV'N	ADJUSTED FOR INDEPENDENTS BETA	ADJUSTED FOR INDEPENDENTS + COVARIATES DEV'N	ADJUSTED FOR INDEPENDENTS + COVARIATES BETA
IP							
1	122	-80.18		26.47			
2	121	34.53		0.14			
3	46	121.84		-70.56			
			0.38		0.17		
PCODE							
0	105	112.98		71.48			
1	184	-64.47		-40.79			
			0.43		0.27		
PLT							
1	75	-62.94		-4.29			
2	214	22.06		1.50			
			0.19		0.01		
MULTIPLE R SQUARED					0.017		
MULTIPLE R					0.130		

sample size in some of the cells. Despite the insignificant F test for the main effect, requisition type explained more variations than either of the other variables.

Summary

In this chapter, we presented the technique used in making a determination of the relationship between the independent variables--requisition type, issue priority, and lead time--on the dependent variable, requisition service days. We discussed how our data departed from the assumptions of the ANOVA model and assessed the effects of those deviations.

We analyzed requisitions for noncritical items and determined that requisition type explained very little of the variation in service time. Our evaluation is that programmed and non-programmed requisitions for investment items in general received equal treatment, measured in requisition service days. However, the same cannot be said of requisitions for critical items. The single-factor and two-factor analysis of variance indicated that requisition type was a significant factor in explaining the variation in service time. The three-way ANOVA of critical items was inconclusive, most probably due to small sample size and the large variance of the factors involved.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter will summarize the significant material presented in the previous chapters before stating the conclusions and highlighting some possible impacts and causes of the results. Although beyond the scope of this research, these possibilities may prove helpful to future efforts recommended later in this chapter.

Chapter 1 introduced the reader to Foreign Military Sales and its importance, then limited the scope of this study to one aspect of FMS: follow-on supply support. After presenting the several methods available to purchase this support, we specifically focused the research on Cooperative Logistics Supply Support Arrangements since they are the recommended method. The problem was to evaluate the supply effectiveness of CLSSAs by comparing the requisition service days for programmed (CLSSA) and non-programmed requisitions (both CLSSA and Blanket Order case demands). In Chapter 2, the available literature on this topic was reviewed and summarized. The dearth of substantive research in this area highlighted the need for analysis and documentation. Chapter 3 described the methodology, variables,

data, procedures, and statistical techniques that were used in providing the needed analysis and documentation in this important area. In Chapter 4, the ANOVA technique was explained and its role in processing the accumulated data described. The results of that analysis provide the basis on which this concluding chapter is written.

Conclusions

In order to achieve the objectives of this thesis, two questions were posed. The research design developed to answer those questions dictated the use of hypothesis testing based on statistical analysis. The data analysis provided the answers to those questions and formed the basis for our conclusions.

> Research Question 1: In there a discernible difference in requisition service days for programmed and non-programmed demands from foreign governments for Air Force-managed investment items?

No statistically discernible difference in requisition service days was evident based on a sample of 875 requisitions for noncritical items. Analysis, based on both programmed and non-programmed requisition types, revealed the following results:

Requisition Type	Average Requisition Service Time
Programmed	209 days
Non-programmed	209 days

When the variables "issue priority" and "procurement lead time" were added as factors possibly affecting this relationship, there was no significant change in average requisition service time for either type of requisition. We concluded that, based upon the data analyzed, there is no difference in service time between programmed and non-programmed demands for Air Force-managed investment items.

The reader will recall that in case no difference between programmed and non-programmed requisitions was found for noncritical items, it was hypothesized that a difference would exist in those requisitions for critical items. From that hypothesis came the second research question.

> Research Question 2: Does item criticality effect differentiated levels of service given to programmed and non-programmed requisitions?

The analysis of 289 requisitions for critical items indicated that requisition type is a significant factor in determining requisition service time for critical items. Requisition service time, based only on requisition type, yielded the following results:

Requisition Type	Average Requisition Service Time
Programmed	74 days
Non-programmed	251 days

When requisition service time was adjusted for the effects of issue priority, requisition type remained a significant factor in the relationship, as shown on the following page.

Requisition Type	Average Requisition Service Time
Programmed	97 days
Non-programmed	211 days

Adding the third variable, procurement lead time, reduced the size of the individual samples to the point that meaningful conclusions could not be made because of the large variance. However, based on the single effects model and the two-way analysis of our data, we feel confident in arriving at the following conclusion: programmed requisitions for critical items enjoy markedly decreased requisition service time compared to non-programmed requisitions. A larger sample would have strengthened this conclusion.

Although current DOD and USAF policy and guidance appear logically to delineate very different levels of FMS follow-on supply support, the logistics system is not, in reality, functioning according to the designed plan. The absolute equality of supply support for programmed and non-programmed demands for replenishment spares in general, as measured in requisition service days, negates the intended advantage of Cooperative Logistics Supply Support Arrangements.

By answering the research questions, the objectives of this study have been achieved. In so doing, we have provided at least one measure of FMS supply effectiveness by comparing average requisition service times for programmed and non-programmed FMS requisitions.

Although beyond the scope of this effort, it is necessary to assess the impact and possible causes of these

conclusions. These possibilities, while not validated by this research, came to our attention during the course of this study.

Possible Impacts

The results of this research corroborate the conclusion, drawn last year by Captains Myers and O'Grady, that programmed demands against Cooperative Logistics Supply Support Arrangements receive no better treatment than non-programmed demands. Thus, there is apparently no pipeline advantage to an FMS customer to project usage or negotiate stock levels by line item, except for critical investment items. The AFLC supply system is not fulfilling the expectations we have created in our CLSSA customers.

Not only do our findings negatively impact our CLSSA customers with programmed requisitions, but the Air Force operational units and AFLC could also be adversely affected. First, programmed CLSSA demands are supposed to receive support equal to that given operational units in our own Air Force. However, our findings show no difference on the average between treatments given to programmed and non-programmed demands. It is therefore possible that non-programmed FMS requisitions are also receiving basically the same treatment as demands from USAF users.

Since there is some evidence to support this possibility, then current practice (as opposed to the written procedures) for filling FMS requisitions may reduce AFLC's ability to support US forces. If non-programmed demands are

being filled from AFLC stock, which is contrary to USAF policy except for items in excess, this could hinder AFLC's responsiveness to requests from USAF users.

Finally, the research results also have an adverse effect on USAF credibility. USAF policy requires a Cooperative Logistics Supply Support Arrangement with every new system sale package. FMS negotiators rely on the advertised claim that CLSSA provides the best supply support available to our customers (18). The belief is widespread that forecasting requirements in advance affords considerable advantage over "blank check" requisitioning, through reduced requisition service time and shorter pipelines. It has been reiterated in DOD and USAF documents. If, however, we assume our sample is representative of all FMS requisitions, then our results show that, except for critical items, we have failed to meet the expectations of programmed CLSSA customers. This failure pertains to both expected stock availability and the stated advantage over non-programmed demands.

Possible Causes

We cannot identify the reasons for the apparent failure of the AFLC logistics system to provide differentiated support to programmed and non-programmed FMS requisitions based on our research. However, we should speculate on some possible causes for the apparent schism between policy and reality for the benefit of future researchers.

First, there could be a large percentage of investment items in excess stock position. If this were true, it

could account for the apparent satisfaction of non-programmed demands in a time period equivalent to that of programmed requisitions. This does not appear likely, however, since we would then expect the average requisition service time to be considerably less than the 209 days we computed.

Second, the complexity of the data system interface may partly account for our findings. In the process of transferring information from H051 to D032 (the "Item Manager Stock Control and Distribution System") to D041, the programmed/non-programmed code could be lost. Some of the non-programmed demands could be mistakenly satisfied by mechanical release of assets. Other data system problems could effect a net result of equal treatment for both types of FMS requisitions.

Next, the possibility of human intervention in the planned operation of the system should not be overlooked. First, we should consider the random errors which may occur. Application of current policy and procedures may vary across the ALCs. Item managers (IMs) perhaps lack a clear understanding of their different responsibilities to programmed and non-programmed requisitions. Also, interpretation of the regulations prescribing requisition fill procedures may be inconsistent.

Other types of human intervention may force manipulation of the system. Item managers receive demand status requests and pleas for special attention from a variety of sources, such as foreign country representatives and USAF

managers within the ILC and the Air Logistics Centers, to prompt better service. Also, the accumulation of many non-programmed backorders would reduce an IM's effectiveness rating unless non-programmed demands were specifically exempted from computing an IM's fill rate.

Finally, the current policy on filling FMS requisitions may require re-examination. It may be unrealistic to expect an item manager to initiate new procurement for every non-programmed requisition for an item with inventory below the support level. Considering the time and effort consumed in amending an existing contract or initiating new procurement, it is probably easier for the IM to "take a chance" and release assets to non-programmed customers. Several thousand new procurement actions per year, specifically for non-programmed demands, represent a significant additional workload to both IMs and procurement officers across AFLC. Perhaps Purchase Requests (PRs) could be initiated automatically by the requirements computation system for all non-programmed requests. This is currently done for routine reprocurement of low-demand EOQ items in AFLC.

The mechanical, human, and policy variables discussed above are only some of the possible causes for our findings. They are not exhaustive and it was not the intent of this research to validate any of the above possibilities. However, we have highlighted them as areas which merit further attention.

Recommendations

After thoughtful consideration of the foregoing conclusions, their possible impacts and causes, the authors of this thesis offer the following recommendations to the sponsors of this research, the International Logistics Center (ILC).

1. ILC personnel should review this study, including the associated assumptions.

2. ILC personnel should initiate actions with the necessary AFLC organizations to acquaint them with the problem and to work cooperatively in isolating the possible causes identified in the previous section. Solutions may be developed only through active interest in this matter by the AFLC Staff.

3. ILC personnel and the AFIT School of Systems and Logistics should continue to coordinate on the related research efforts to be completed in September 1979.

Finally, in light of the potential impacts mentioned earlier, we suggest that AFLC efforts be accomplished as a priority matter.

Final Summary

This thesis met the objectives by answering the research questions posed in Chapter 1. Additionally, we have provided a documented effort where analytical research was lacking. Following the methodology provided in Chapter 3,

we identified our dependent variable, requisition service days, and our primary independent variable, requisition type. Other variables were identified and included in the analysis presented in Chapter 4.

By comparing programmed and non-programmed requisitions for USAF-managed investment items, we found no statistically significant difference for the general investment items, labeled herein as noncritical. We did, however, identify a statistically significant difference in requisition service time for critical investment items. Conclusions, possible impacts and causes, as well as recommendations, were provided in this final chapter. In addition to achieving our research objectives, we also provided statistical evidence that a problem exists with CLSSA, emphasizing the need for action and additional research in this extremely important area of FMS follow-on supply support.

APPENDICES

APPENDIX A

GLOSSARY OF TERMS

AD-A083 026 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/G 15/5
THE SUPPLY EFFECTIVENESS OF COOPERATIVE LOGISTICS.(U)
JUN 79 K D PENDLEY, G L RATLEY
UNCLASSIFIED AFIT-LSSR-28-79A NL

2 OF 2

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END
DATE FILMED
5-80
DTIC

Administrative Lead Time. The time interval between initiation of procurement action and letting of contract or placing of order [16:A1-1].

Concurrent Spare Parts. Spare parts programmed for package shipment at the same time as or before delivery of the related major items [16:A1-1].

Excess Defense Articles. Defense articles owned by the USG and not procured in anticipation of military assistance or sales requirements, or pursuant to a military assistance or sales order, which are in excess of the Approved Force Acquisition Objective and Approved Force Retention Stock of all Department of Defense Components at the time such articles are dropped from inventory by the supply agency for delivery to countries or international organizations [16:A1-]].

Excess Property. The quantity of property in possession of any component of the Department of Defense which exceeds the quantity required or authorized for retention by that component [16:A1-3].

FMS Case. Any transaction for which an FMS case identifier has been assigned. Categories of cases include:

a. Blanket Order FMS Case. A case established for a category of items or services with no definitive listing of specific items or quantities. The case specifies a dollar ceiling against which the purchaser may place orders throughout the validity

period defined in the case.

b. Closed Case. One for which deliveries have been completed or all services provided, and for which all financial transactions have been completed.

c. Completed Case. One for which deliveries have been completed or all services provided, and for which financial actions have not been completed.

d. Firm Order Case. A case established to purchase specific quantities of defined items or services (as opposed to a blanket order case).

e. Open FMS Case. An FMS case is designated open as long as any portion of the transaction is incomplete, i.e., delivery of materiel, performance of services, financial transactions, or rendering of the final statement of accounts (16:A1-3).

FMS Case Identifier. A specific designation assigned to each FMS case, consisting of a two alpha country code and a three alpha designator (for example, AT-ABC, AT-Australia, ABC-Case designator) [16:A1-3].

Foreign Military Sales. The selling of military equipment and services to friendly foreign governments and international organizations under the authority of the Foreign Military Sales Act of 1968, as amended [16:A1-3].

Initial Spares and/or Repair Parts. The spare and/or repair parts, assemblies, and components required to support and maintain an item/article delivered under a contract during its initial phase of service [16:A1-4].

International Logistics. The negotiating, planning, and implementation of supporting logistics arrangements between nations, their forces, and agencies. It includes furnishing logistics support (major end items, materiel, or services) to, or receiving logistic support from, one or more friendly foreign governments, international organizations, or military forces, with or without reimbursement. It also includes planning and actions related to the intermeshing of a significant element, activity, or component of the military logistics systems or procedures of the US with one or more foreign governments, international organizations, or military forces on a temporary or permanent basis. In includes planning and actions related to the utilization of US logistics, policies, systems, procedures to meet requirements of one or more foreign governments, international organizations or forces [16:A1-4].

Major Item of Equipment. A complete assembly which is designed to perform a specific function within itself which has significant impact on mission accomplishment (for example, aircraft, heavy radar equipment, vehicles, and SE) as distinguished from an individual part or component [16:A1-4].

Military Assistance Program. Logistics support provided to the customer country at no cost to the customer. Under the FAA the Air Force receives reimbursement from Foreign Assistance Act Funds for the total cost of support provided other than excess items. Programs within MAP are annual

(fiscal year) and relate to specific military assistance requirements by area and country. MAP is also commonly referred to as "Grant Aid" [16:A1-5].

Not Mission Capable, Supply. A condition status of an item of equipment or a system, in the possession of an operational unit, indicating that it is not operationally ready nor can maintenance work be performed to return it to an operationally ready status until the required items of supply become available at the work site. Also called NMCS [16:A1-5].

Price and Availability Study. The effort required to prepare P & A data (estimated dollar cost and estimated delivery dates) for use in the preparation of a LOA [16:A1-5].

Procurement Lead Time. The interval in months between the initiation of procurement action and receipt into the supply system of the production model (excludes prototypes) purchased as the result of such actions, and is composed of two elements, production lead time and administrative lead time [16:A1-5].

Production Lead Time. The time interval between the placement of a contract and receipt into the supply system of material purchased. Two entries are provided: a) initial--the time interval if the item is not under production as of the date of contract placement; b) reorder--the time interval if the item is under production as of the date of contract placement [16:A1-6].

Purchaser. Any friendly foreign country or international organization determined by the President to be eligible to

make purchases under the Foreign Military Sales Act [16:A1-6].

Reparable Item. An item which can be reconditioned or economically repaired for reuse when it becomes unserviceable [16:A1-6].

Security Assistance. Includes all DOD activities carried out under the authority of the Foreign Military Sales Act or Foreign Assistance Act, or related appropriations acts and other related statutory authorities [16:A1-6].

Spare. An individual part, sub-assembly or assembly supplied for the maintenance or repair of systems of equipment [16:A1-6].

Supply Support Arrangement. A concept whereby the follow-on supply support of certain spare parts for equipment of US origin possessed by an eligible recipient is provided through purchaser participation in the USAF logistics system [16:A1-6].

Weapon System. A weapon and those components required for its operation. It is a composite of equipments, skills and techniques that form an instrument of combat which, usually, but not necessarily, has an aerospace vehicle as its major operational element. The complete weapon system includes all related facilities, equipment, materiel, services, and personnel required solely for the operation of the aerospace vehicle, or other major elements of the system, so that the instrument of combat becomes a self-sufficient unit of striking power in its intended operational environment [16:A1-7].

APPENDIX B

CRITICAL ITEM SUMMARY REPORT

							GET WELL DATE					
NR	ALC	NSN	NOUN	ERRC	MPN/SYS	CAUSE	PRI 1-8	PRI 9-15	CRIT MOS	TRC	IM & EXT	
1	SM	1055000226503280J	INTERVALOM	XB3	F111A-C	V	01 78	02 78	03	NA	DOW	4735
2	WR	127C007137971	INDICATOR	XD2	F106	O	02 78	05 78	01	WR	WILLIAMS	2717
3	WR	127C007650197	INDICATOR	XD2	F106	O	03 78	04 78	02	WR	WILLIAMS	2717
4	WR	1270008912318	POWER SUPPL	XD2	F106	O	02 78	03 78	08	WR	STEWART	2717
5	WR	1280001675553	TUBE ASSY	XD2	B52	O	03 78	05 78	03	WR	PURDUE	5971
6	00	143C0010667389F	MIXER ASSY	XD2	F4CDE	E4	03 78	03 78	08	WR	FARR	5481
7	00	143C0013410698F	RATE GYRO	XD2	F4CDE	N	11 77	11 77	08	CC	DICKAMORE	5481
8	00	143C0022156068F	IND CNTL	XD3	F4D	O	03 78	04 78	04	WR	SMEDLEY	5481
9	OC	1430002767486CJ	CARD CIR	XD2	AGM69A	M	12 77	02 78	03	OO	LO BROWN	2568
10	OC	1430004671053CJ	ECI	XD2	B52	O	03 78	04 78	02	OO	O HARPER	2246
11	00	143C0680907718F	MAGNETIC ST	XD2	F4D	4	11 77	04 78	08	WR	FARR	5481
12	00	143C0091900359F	TIME MODULE	XD2	F4D		12 77	12 77	08	WR	SMEDLEY	5481
13	00	143C0094418278F	TIME DISCRM	XD2	F4D	4	12 77	01 78	08	WR	SMEDLEY	5481
14	OC	156C000482041FG	RADOME	XD2	B52	B	10 78	UN KN	01	OC	D HARPER	2246
15	SM	1560001845845BJ	COUNTERPOIS	XD2	F111ALL	NP	02 78	04 78	03	SM	GUSTAFSON	4827
16	SA	156C002489164LH	RAIL ASBLY	XD2	C5A	V	06 78	06 78	05	SA	GARZA-56114	
17	SA	156C002489165LH	RAIL ASBLY	XD2	C5A	V	02 78	02 78	05	SA	GARZA-56114	
18	SA	156C004342102EV	TANK OIL	XD2	OV10	N	02 78	02 78	01	CC	LECOMTE-56114	
19	SA	156C0C5687403SE	QUADRANT	XB3	T37B	5	07 78	07 78	01		OLENICK-56804	
20	SA	1560006026450LH	BRACKET	XB3	C5A	V	12 77	12 77	04		PHILLIPS-57231	

APPENDIX C

LIST OF SAMPLED NONCRITICAL AND CRITICAL NSNs

Noncritical Items

Number	NSN	ALC	PLT
1	1270010099328	WRALC	12
2	1610008625524	WRALC	16
3	1660004463831	OCALC	18
4	1660007935799	OCALC	19
5	1660007983210	OCALC	18
6	1680004110966	SAALC	12
7	1680004257532	SAALC	16
8	1680006708313	SAALC	20
9	2840001398661RU	OCALC	16
10	2840003025582PL	OCALC	18
11	2840004424458PL	OCALC	11
12	2915006241894PL	OCALC	15
13	2935000947923	OCALC	12
14	2995003977668RX	SAALC	13
15	4820000019968BF	OOALC	11
16	4810007302852TP	OCALC	16
17	4820004977437BF	OOALC	18
18	4810007827732HS	OCALC	9
19	4810009873948YQ	OCALC	10
20	5841007596990	WRALC	14
21	5895003558518ZW	SMALC	12
22	6115009031256BF	OOALC	16

Number	NSN	ALC	PLT
23	6125006695968	SMALC	13
24	6340000158049	SAALC	
25	6605000563113	OCALC	24
26	1605004479665	OCALC	12
27	6605009490273	OCALC	19
28	6610005315387	OCALC	12
29	6680007900082	SAALC	17
30	1270007944969CB	WRALC	
31	1430000541069BF	OOALC	18
32	1620001233947	OOALC	18
33	1270004767946	WRALC	21
34	1270006268795	WRALC	12
35	1610002490800	WRALC	9
36	1650007395064BF	OOALC	20
37	1630009089999	OOALC	15
38	1650007906861BF	OOALC	18
39	1660003975055	OCALC	19
40	1660003992368	OCALC	19
41	2810009330209AA	SAALC	11
42	2840007041301RX	SAALC	17
43	2840007586317RU	OCALC	13
44	4320006740932RW	SAALC	14
45	4320007989968ZW	SMALC	18
46	5821006733101	WRALC	12
47	5840004422530ZC	SMALC	15
48	5841005803766	WRALC	12

Number	NSN	ALC	PLT
49	5841001728888	WRALC	16
50	5895001151029	WRALC	13
51	6610000089566	OCALC	13
52	6110009386893	SMALC	13
53	6610009898889BF	OOALC	11
54	6615009116456BF	OOALC	23
55	5826005260741	WRALC	12
56	1560006329872GU	OOALC	14

Critical Items

1	1430009190035BF	OOALC	19
2	1680006728931	SAALC	13
3	2810000146114PD	SAALC	16
4	2840007612675PJ	OCALC	23
5	2840007803486RX	SAALC	24
6	2910009081429YP	SAALC	18
7	2915007821759RX	SAALC	13
8	4320004380052AX	SAALC	13
9	6110007270792	SMALC	18
10	6615009732657	OCALC	13
11	6615007946285BF	OOALC	17
12	6615007961466BF	OOALC	17
13	6680005801247	SAALC	17
14	6680008786133	SAALC	16
15	2920000600057YP	SAALC	15

APPENDIX D

HISTOGRAMS OF VARIABLE DISTRIBUTIONS

```
NONCRITICAL ITMES USING PROGRAMMED REQUISITIONS


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
* - CUMULATIVE DENSITY MATCHES THEORETICAL

0. 26.50 53.00 79.50 106.00 132.50 159.00 185.50 212.00
* * * * * * * *
......................................................................
.........
LT MIN *.
15.0 *.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIII*
45.0 *.IIIIII*
75.0 *.IIIIII*
105.0 *.II*
135.0 *.III*
165.0 *.II*
195.0 *.III*
225.0 *.II*
255.0 *.I*
285.0 *.
315.0 *.I*
345.0 *.*
375.0 *.*
405.0 *.IIIIII*
435.0 *.*
465.0 *.II*
495.0 *.I*
525.0 *.II*
555.0 *.*
585.0 *.II*
615.0 *.II*
645.0 *.III*
675.0 *.IIII*
705.0 *.II*
735.0 *.I*
GT MAX *.
765.0 *.
795.0 *.
825.0 *.
```

```
NONCRITCIAL ITEMS USING UNPROGRAMMED REQUISITIONS


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
* - CUMULATIVE DENSITY MATCHES THEORETICAL

0. 21.50 43.00 64.50 86.00 107.50 129.00 150.50 172.00
* * * * * * * *
......................................................................
.........
LT MIN *.
15.0 *.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIIII*
45.0 *.IIIIII*
75.0 *.IIIIIII*
105.0 *.IIIIII*
135.0 *.IIIIIIIII*
165.0 *.III*
195.0 *.II*
225.0 *.IIIII*
255.0 *.IIII*
285.0 *.I*
315.0 *.*
345.0 *.III*
375.0 *.IIII*
405.0 *.II*
435.0 *.I*
465.0 *.I*
495.0 *.I*
525.0 *.IIIIIIII*
555.0 *.IIIIIII*
585.0 *.II*
615.0 *.III*
645.0 *.*
675.0 *.IIIII*
705.0 *.
735.0 *.I*
GT MAX *.I
765.0 *.
795.0 *.
825.0 *.
```

```
NONCRITICAL ITEMS USING ISSUE PRIORITY 1 DATA


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
* - CUMULATIVE DENSITY MATCHES THEORETICAL

0. 16.63 33.25 49.88 66.50 83.13 99.75 116.38 133.00
* * * * * * * *
 .......................................................................
.........
 LT MIN *.
 15.0 *.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIIII*
 45.0 *.II*
 75.0 *.IIIIII*
 105.0 *.*
 135.0 *.IIIII*
 165.0 *.*
 195.0 *.
 225.0 *.III*
 255.0 *.III*
 285.0 *.
 315.0 *.*
 345.0 *.*
 375.0 *.*
 405.0 *.IIIIIIII*
 435.0 *.I*
 465.0 *.IIII*
 495.0 *.I*
 525.0 *.II*
 555.0 *.II*
 585.0 *.IIII*
 615.0 *.III*
 645.0 *.II*
 675.0 *.IIIIII*
 705.0 *.*
 735.0 *.II*
 GT MAX *.
 765.0 *.
 795.0 *.
 825.0 *.
```

```
NONCRITICAL ITEMS USING ISSUE PRIORITY 2 DATA


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
* - CUMULATIVE DENSITY MATCHES  HEORETICAL

0. 22.13 44.25 66.38 88.50 110.63 132.75 154.88 177.00
* * * * * * * *
 ......................................................................
.........
 LT MIN *.
 15.0 *.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIIII*
 45.0 *.IIIIIII*
 75.0 *.IIIIII*
 105.0 *.IIIIIIII*
 135.0 *.IIIIIIII*
 165.0 *.III*
 195.0 *.IIIII*
 225.0 *.I*
 255.0 *.I*
 285.0 *.*
 315.0 *.*
 345.0 *.II*
 375.0 *.II*
 405.0 *.II*
 435.0 *.*
 465.0 *.I*
 495.0 *.I*
 525.0 *.IIIIIIII*
 555.0 *.IIIIII*
 585.0 *.II*
 615.0 *.II*
 645.0 *.II*
 675.0 *.IIII*
 705.0 *.II*
 735.0 *.I*
 GT MAX *.
 765.0 *.
 795.0 *.
 825.0 *.
```

```
NONCRITICAL ITEMS USING ISSUE PRIORITY 3 DATA


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
* - CUMULATIVE DENSITY MATCHES THEORETICAL

0. 9.25 18.50 27.75 37.00 46.25 55.50 64.75 74.00
* * * * * * * * *
................................................................
..........
LT MIN *.
15.0 *.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIIIII*
45.0 *.IIIIIIIIIIIIII*
75.0 *.IIIIIIII*
105.0 *.*
135.0 *.I*
165.0 *.III*
195.0 *.II*
225.0 *.IIIIIIII*
255.0 *.III*
285.0 *.II*
315.0 *.III*
345.0 *.III*
375.0 *.III*
405.0 *.IIII*
435.0 *.II*
465.0 *.*
495.0 *.*
525.0 *.III*
555.0 *.
585.0 *.
615.0 *.II*
645.0 *.*
675.0 *.*
705.0 *.
735.0 *.*
GT MAX *.I
765.0 *.
795.0 *.
825.0 *.
```

```
NONCRITICAL ITEMS USING PLTI DATA


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
+ - CUMULATIVE DENSITY MATCHES THEORETICAL

0. 11.50 23.00 34.50 46.00 57.50 69.00 80.50 92.00
+ + + + + + + + +
........................................................................
.........
LT MIN +.
15.0 +.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIIII+
45.0 +.IIIII+
75.0 +.IIIIIIIIII+
105.0 +.III+
135.0 +.II+
165.0 +.IIIII+
195.0 +.IIIII+
225.0 +.IIII+
255.0 +.II+
285.0 +.+
315.0 +.
345.0 +.I+
375.0 +.III+
405.0 +.I+
435.0 +.
465.0 +.
495.0 +.
525.0 +.
555.0 +.
585.0 +.
615.0 +.
645.0 +.
675.0 +.
705.0 +.
735.0 +.
GT MAX +.
765.0 +.
795.0 +.
825.0 +.
```

```
NONCRITICAL ITEMS USING PLT2 DATA MEDIUM LEAD TIME


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
* - CUMULATIVE DENSITY MATCHES THEORETICAL

0. 26.13 52.25 78.38 104.50 130.63 156.75 182.88 209.00
* * * * * * * *
........................................................................
.........
LT MIN *.
15.0 *.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIIII*
45.0 *.IIIIIII*
75.0 *.IIIIII*
105.0 *.I*
135.0 *.II*
165.0 *.I*
195.0 *.I*
225.0 *.II*
255.0 *.I*
285.0 *.*
315.0 *.I*
345.0 *.*
375.0 *.II*
405.0 *.IIIIIII*
435.0 *.II*
465.0 *.I*
495.0 *.*
525.0 *.I*
555.0 *.*
585.0 *.
615.0 *.
645.0 *.
675.0 *.
705.0 *.
735.0 *.
GT MAX *.
765.0 *.
795.0 *.
825.0 *.
```

```
NONCRITICAL ITEMS USING PLT3 DATA LONG LEAD TIME


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
* - CUMULATIVE DENSITY MATCHES THEORETICAL

0. 10.38 20.75 31.13 41.50 51.88 62.25 72.63 83.00
* * * * * * * * *
.......................................................................
.........
 LT MIN *.
 15.0 *.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIII*
 45.0 *.IIIII*
 75.0 *.II*
 105.0 *.IIIIIIIIIII*
 135.0 *.IIIIIIIIIIIIIIIIII*
 165.0 *.II*
 195.0 *.III*
 225.0 *.IIIII*
 255.0 *.IIII*
 285.0 *.
 315.0 *.I*
 345.0 *.IIIII*
 375.0 *.
 405.0 *.I*
 435.0 *.*
 465.0 *.IIIIII*
 495.0 *.IIII*
 525.0 *.IIIIIIIIIIIIIIIIIIIIIII*
 555.0 *.IIIIIIIIIIIIIII*
 585.0 *.IIIIIIIIIIIII*
 615.0 *.IIIIIIIIIIII*
 645.0 *.IIIIIIIIIIII*
 675.0 *.IIIIIIIIIIIIIIIIIIIIIIII*
 705.0 *.IIIIIIII*
 735.0 *.IIIIIIIII*
 GT MAX *.III
 765.0 *.
 795.0 *.
 825.0 *.
```

```
CRITICAL ITMES USING PCODE1 DATA PROGRAMMED REQUISITIONS


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
+ - CUMULATIVE DENSITY MATCHES THEORETICAL

0. 14.88 29.75 44.63 59.50 74.38 89.25 104.13 119.00
+ + + + + + + + +
........................................................................
..........
LT MIN +.
15.0 +.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIIII+
45.0 +.IIIIIII+
75.0 +.IIII+
105.0 +.III+
135.0 +.II+
165.0 +.I+
195.0 +.III+
225.0 +.+
255.0 +.II+
285.0 +.
315.0 +.+
345.0 +.I+
375.0 +.
405.0 +.+
435.0 +.+
465.0 +.
495.0 +.
525.0 +.
555.0 +.
585.0 +.+
615.0 +.+
645.0 +.
675.0 +.
705.0 +.
735.0 +.
GT MAX +.
765.0 +.
795.0 +.
825.0 +.
```

```
CRITICAL ITEMS USING PCODE0 DATA


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
* - CUMULATIVE DENSITY MATCHES THEORETICAL

0. 3.63 7.25 10.88 14.50 18.13 21.75 25.38 29.00
* * * * * * * * *
.............................................................................
.........
LT MIN *.
15.0 *.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIII*
45.0 *.IIIIIIIIIIIIIIIIIIIIIIIIII*
75.0 *.IIIIIII*
105.0 *.IIIIIIIIIIIIIIIIII*
135.0 *.IIIIIII*
165.0 *.IIII*
195.0 *.IIIIIIIIII*
225.0 *.IIIIIII*
255.0 *.IIIIIII*
285.0 *.I*
315.0 *.IIII*
345.0 *.I*
375.0 *.IIIIIIIIIIII*
405.0 *.I*
435.0 *.I*
465.0 *.IIIIIII*
495.0 *.IIIIIIIIII*
525.0 *.IIIIIII*
555.0 *.IIIIIIIIII*
585.0 *.IIII*
615.0 *.IIIIIIIIIIII*
645.0 *.IIIIIII*
675.0 *.IIII*
705.0 *.I*
735.0 *.IIII*
GT MAX *.
765.0 *.
795.0 *.
825.0 *.
```

```
CRITICAL ITEMS USNG IP1 ISSUE PRIORITY NMCS (NORS)


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
* - CUMULATIVE DENSITY MATCHES THEORETICAL

0. 1.38 2.75 4.13 5.50 6.88 8.25 9.63 11.00
* * * * * * * *
........................................................................
.........
 LT MIN *.
 15.0 *.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIII*
 45.0 *.IIIIIIIIIIIIIIIIIIII*
 75.0 *.IIIIII*
 105.0 *.IIIIIIIIIIIII*
 135.0 *.IIIIII*
 165.0 *.IIIIII*
 195.0 *.
 225.0 *.
 255.0 *.
 285.0 *.
 315.0 *.IIIIII*
 345.0 *.
 375.0 *.IIIIII*
 405.0 *.
 435.0 *.IIIIII*
 465.0 *.
 495.0 *.
 525.0 *.IIIIII*
 555.0 *.IIIIII*
 585.0 *.
 615.0 *.
 645.0 *.IIIIII*
 675.0 *.
 705.0 *.
 735.0 *.
 GT MAX *.
 765.0 *.
 795.0 *.
 825.0 *.
```

```
CRITICAL ITEMS USING IP2 DATA ISSUE PRIORITY 1-8


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
* - CUMULATIVE DENSITY MATCHES THEORETICAL

0. 1.63 3.25 4.88 6.50 8.13 9.75 11.38 13.00
* * * * * * * * *
...................................................................
.........
LT MIN *.
15.0 *.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIII*
45.0 *.IIIIIIIIIIIIIIIIIIIIIII*
75.0 *.IIIIIIIIIII*
105.0 *.IIIIIIIIIIIIIIIII*
135.0 *.IIIII*
165.0 *.IIIII*
195.0 *.IIIII*
225.0 *.IIIIIIIIIIIIIIIII*
255.0 *.IIIIIIIIIII*
285.0 *.
315.0 *.
345.0 *.
375.0 *.IIIIIIIIIIIIIIIIIIIIIII*
405.0 *.IIIII*
435.0 *.
465.0 *.IIIIIIIIIII*
495.0 *.IIIII*
525.0 *.IIIIIIIIIII*
555.0 *.IIIIIIIIIIIIIIIII*
585.0 *.IIIII*
615.0 *.IIIIIIIIIIIIIIIII*
645.0 *.IIIIIIIIIII*
675.0 *.IIIII*
705.0 *.IIIII*
735.0 *.
GT MAX *.
765.0 *.
795.0 *.
825.0 *.
```

```
CRITICAL ITEMS USING IP3 DATA ISSUE PRIORITY 9-15


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
+ - CUMULATIVE DENSITY MATCHES THEORETICAL

0. 0.63 1.25 1.88 2.50 3.13 3.75 4.38 5.00
+ + + + + + + + +
..................................................................
..........
LT MIN +.
15.0 +.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIIII+
45.0 +.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII+
75.0 +.
105.0 +.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIII+
135.0 +.IIIIIIIIIIIIIII+
165.0 +.
195.0 +.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII+
225.0 +.
255.0 +.IIIIIIIIIIIIIII+
285.0 +.IIIIIIIIIIIIIII+
315.0 +.IIIIIIIIIIIIIII+
345.0 +.IIIIIIIIIIIIIII+
375.0 +.
405.0 +.
435.0 +.
465.0 +.IIIIIIIIIIIIIII+
495.0 +.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII+
525.0 +.
555.0 +.
585.0 +.IIIIIIIIIIIIIII+
615.0 +.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIII+
645.0 +.
675.0 +.IIIIIIIIIIIIIII+
705.0 +.
735.0 +.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIII+
GT MAX +.
765.0 +.
795.0 +.
825.0 +.
```

```
CRITICAL ITEMS USING PLT 1 SHORT LEAD TIME DATA


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
* - CUMULATIVE DENSITY MATCHES THEORETICAL

0. 5.50 11.00 16.50 22.00 27.50 33.00 38.50 44.00
* * * * * * * *
.........................................................................
.........
LT MIN *.
15.0 *.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIIII*
45.0 *.IIIIIIIIIIIIIIIIII*
75.0 *.IIIIII*
105.0 *.IIIIII*
135.0 *.
165.0 *.II*
195.0 *.
225.0 *.*
255.0 *.*
285.0 *.
315.0 *.*
345.0 *.IIII*
375.0 *.II*
405.0 *.II*
435.0 *.*
465.0 *.
495.0 *.
525.0 *.
555.0 *.
585.0 *.
615.0 *.
645.0 *.
675.0 *.
705.0 *.
735.0 *.
GT MAX *.
765.0 *.
795.0 *.
825.0 *.
```

```
CRITICAL ITMES USING PLT2 LONG LEAD TIME DATA


HISTOGRAM OF DATA AND CURVE APPROXIMATION
LEGEND:
I - CELL DENSITY
. - FITTED TO THE CUMULATIVE
* - CUMULATIVE DENSITY MATCHES THEORETICAL

0. 13.00 26.00 39.00 52.00 65.00 78.00 91.00 104.00
* * * * * * * *
.........................................................................
.........
LT MIN *.
15.0 *.IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
IIIIIIIIIIIIII*
45.0 *.IIIIIIII*
75.0 *.IIII*
105.0 *.IIIIII*
135.0 *.IIIII*
165.0 *.II*
195.0 *.IIIIII*
225.0 *.II*
255.0 *.IIII*
285.0 *.*
315.0 *.I*
345.0 *.
375.0 *.II*
405.0 *.
435.0 *.*
465.0 *.I*
495.0 *.II*
525.0 *.I*
555.0 *.II*
585.0 *.II*
615.0 *.IIII*
645.0 *.I*
675.0 *.*
705.0 *.
735.0 *.*
GT MAX *.
765.0 *.
795.0 *.
825.0 *.
```

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